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ART STUDIES

THE LABYRINTH OF SYMBOLS: THE HIDDEN SYMBOLIC SYSTEM IN RENAISSANCE PAINTING AND THE "DECODING" PLEASURE OF THE VIEWER

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ABSTRACT

This paper examines Renaissance painting as an intricate "visual codebook." Through symbolic elements such as flowers, animals, light, and shadow, the paintings integrate religious, classical, and humanist knowledge to construct a multi-layered system of meaning. The act of decoding by viewers was not merely an intellectual game or spiritual edification but also a practical activity that demonstrated cultural capital and social identity, from which they derived unique aesthetic and cognitive pleasure.

Keywords: Renaissance; Painting; Viewer; Decoding; Aesthetics; Cognition.

I. Introduction: Renaissance Painting as a "Visual Codebook"

When we gaze upon paintings from the Renaissance period, we are confronted not with "artworks" meant solely for aesthetic contemplation as in modern galleries, but with a meticulously compiled visual codebook awaiting decipherment. The paintings of this era, from Jan van Eyck's minutely detailed altarpieces to Sandro Botticelli's poetic allegories, are imbued with two layers of reality: one is the beautiful imagery visible to the naked eye, and the other is a vast and intricate symbolic system woven from flowers, fruits, animals, gestures, light, and even color. This system was not the whimsical creation of artists but was deeply rooted in the shared intellectual universe of the time—it fused the Christian tradition of allegorical exegesis, revived classical mythology, folk allegories, natural philosophy, and emerging humanist thought. Therefore, a painting's true "completion" did not occur when the artist laid down the final brushstroke, but at the moment when the ideal contemporary viewer successfully "decoded" these symbols using their reservoir of knowledge, comprehending its moral lessons, theological ideas, or personal and political messages.

Understanding this "codebook" property requires a crucial shift in perspective: from the passive, personalized "viewing" of the modern spectator to the active, culturally embedded "reading" and "decoding" of the historical participant. Patrons, scholars, and educated citizens of Renaissance art derived unique intellectual pleasure and spiritual satisfaction precisely from this puzzle-solving game. This pleasure stemmed both from the apprehension of sacred truth or classical wisdom and from the affirmation of one's own cultural refinement and social standing.

II. The Constituent Elements and Sources of the Renaissance Symbolic System

The huge and intricate symbolic system in Renaissance painting did not emerge from a vacuum but was grounded in a complex and profound historical knowledge tradition. Its constituent elements primarily stem from three intertwined sources: First, the millennium-spanning tradition of Christian iconography, which provided art with a standardized visual vocabulary for saints, virtues, vices, and theological concepts. For example, the lily represents the purity of the Virgin Mary, the lamb symbolizes the sacrifice of Christ, and keys denote the authority of the Apostle Peter. This system originated from the Bible, patristic writings, saints' biographies, and the medieval prevalence of Biblical allegorical exegesis, making images a "Bible of the Poor" for the faithful, carrying clear religious instructional functions.

Secondly, with the revival of classical culture, Greek and Roman mythology, literature, and philosophy became another crucial repository of symbols. Humanist scholars rediscovered works like Ovid's Metamorphoses, where mythological stories and figures were endowed with new moral or philosophical meanings. For instance, Venus could represent carnal love but also symbolize divine love or the harmonious creative force of the cosmos; the choice of Hercules became an allegory for virtue overcoming pleasure. Collaborating with learned patrons or advisors, painters skillfully fused and translated these classical motifs with Christian thought, creating images that both conformed to the taste of the times and contained profound ideas. This "classical rebirth" not only provided rich subject matter but also introduced a mode of symbolic thinking—expressing abstract ideas through specific stories and imagery.

Finally, this symbolic system extensively incorporated prevalent secular knowledge systems, including natural history (e.g., Pliny the Elder's Natural History), allegorical literature, heraldry, and even alchemical and astrological symbols. A medieval bestiary might inform a painter that a unicorn could only be tamed by a virgin, naturally making it a perfect metaphor for the Incarnation of Christ; various plants in a garden, from ivy symbolizing fidelity to the rose representing transience, carried specific moral lessons. These symbols from "science" and folk wisdom, superimposed with religious and classical elements, turned a painting into a

network of knowledge that could be interpreted layer by layer. Therefore, the Renaissance symbolic system was essentially a great synthesis of "Christian tradition, classical revival, and secular learning" at a specific historical moment. It required viewers to possess corresponding knowledge reserves to unravel the pictorial puzzles, thereby transforming art appreciation into an advanced intellectual activity and a marker of social identity.

III. The Operational Mechanisms of Symbols and Decoding Practices in Different Types of Painting

The symbolic system of Renaissance painting was not a rigid, universal dictionary; its vitality and charm lie precisely in the flexible and varied operational mechanisms within different types of works and the tacit decoding practices formed with specific viewer groups. Understanding this mechanism and practice requires us to delve into specific contexts to see how symbols function within particular pictorial logics and social networks.

In religious altarpieces serving public worship, the operation of symbols displayed distinct hierarchy and didactic purpose. Taking Jan van Eyck's Ghent Altarpiece as an example, its intricate symbolic elements—from the plants symbolizing the Four Cardinal Virtues surrounding the sacrificial lamb to the precisely inlaid gems before God's throne—collectively construct a strictly ordered theological universe pointing to a singular truth. The operational mechanism here is "cumulative": while narrating the core religious story, the painting deepens its theological depth and moral instruction layer by layer through peripherally embedded symbols. Contemporary decoding practices also corresponded to viewers' levels of religious knowledge: ordinary believers might recognize the lamb as representing Christ, gaining basic pious sentiment, while erudite clergy could interpret more details pointing to complex doctrines, such as transubstantiation or the sequence of salvation. This public decoding reinforced the shared cognition and collective awe of the faith community.

Shifting to portraits and mythological themes created for private spaces or specific patrons, the operational mechanism of symbols became more personalized, obscure, even tinged with the color of an intellectual game. In Botticelli's Portrait of a Young Man, the medal with a flame emblem and inscription held by the figure is not ordinary adornment. It was likely a carefully chosen object closely related to the Medici family or their cultural circle. Its operational mechanism is "key-like": this symbolic object becomes the sole key to unlocking the painting's deeper meaning, its significance entirely dependent on shared knowledge within a specific small circle. Decoding practice thus becomes an initiation ritual for insiders. Only viewers who could identify the emblem's origin and the inscription's meaning (limited to the patron's friends, family, or political allies) could grasp the sitter's loyalty to a specific group, his humanist cultivation, or a certain political statement. Outsiders unable to decode could only remain at the level of appreciating his countenance and skill. The pleasure here lies in the intellectual superiority and group identity afforded by exclusive understanding.

Similarly, in paintings derived from classical mythology, symbol operation presents a complex mechanism of "translation and dialogue." Taking Botticelli's Primavera as an example, the figures and interactions of classical gods in the scene are not mere recreations of pagan stories but are cleverly translated into visual allegories conforming to the Neoplatonic philosophical ideas prevalent in Florence at the time. The scene of Zephyrus chasing the nymph Chloris might symbolize the material world's intrusion upon the soul; the courtyard ruled by the central Venus might represent the soul's journey from the sensory world to divine ideas under the guidance of Love. This decoding practice required the audience to possess considerable humanist learning, capable of connecting Ovid's poetry with Ficino's philosophical discourse. The painting thus became a visual medium for advanced intellectual dialogue within the small circle of the patron, Lorenzo di Pierfrancesco de' Medici, and his humanist friends. The pleasure of appreciation came from recognizing, beyond sensory beauty, that set of abstract speculation concerning love, beauty, and the fate of the soul.

Finally, in spaces with highly specific functions like court decorations or private studies, symbol operation often served direct political propaganda or the construction of family glory. For instance, Andrea Mantegna's frescoes in the Camera degli Sposi of the Ducal Palace in Mantua juxtapose the deeds of the patron Gonzaga family with imagery of Roman imperial triumph. Its' operational mechanism is "assimilative" aiming to legitimize and elevate the contemporary ruler's prestige through the endorsement of classical authority symbols. Here, the decoding practice served, for visiting foreign envoys or princes, as an intuitive display of power and culture; for family members and courtiers, it was a daily reminder and reinforcement of their own status and loyalty.

In summary, the vitality of symbols in Renaissance painting lies precisely in the fact that their operation and decoding were never fixed. They functioned like a flexible language, adjusting their grammar and rhetoric according to the type of work, its setting, and its target audience. From public sermons in churches to private whispers in studies, from the visualization of philosophical speculation to declarations of political power, symbols moved through different socio-cultural spaces, weaving a network of meaning that was both shared and stratified. The pleasure of decoding arose from the viewer successfully locating themselves within this network and "cracking" the exclusive message using their own knowledge, thereby gaining intellectual satisfaction and a sense of cultural belonging.

IV. The Social Function, Cultural Significance, and Contemporary Implications of Decoding

During the Renaissance, the act of "decoding" the symbolic system in painting was far more than a mere intellectual game or aesthetic activity; it was deeply embedded in the social structure, cultural networks, and spiritual life of the time, serving multiple social functions and shaping a unique cultural significance. This practice of seeking and understanding hidden information within images was, first and foremost, an important mechanism for **social identity marking and distinction**. Proficiency in identifying metaphors

from classical mythology, complex symbols of Christian theology, or a patron family's private emblems signified that an individual possessed the corresponding educational background, classical learning, and leisure time—all core cultural capital of the elite stratum. Thus, decoding ability became an invisible threshold separating the learned nobility, humanists, and wealthy merchants from the general populace. Appreciating a painting replete with allusions in a court or private residence and interpreting its subtleties on the spot was a highly regarded social performance that could consolidate in-group identify, showcase taste and wisdom, and even serve as a non-verbal medium for political alliance and cultural dialogue. Patrons' enthusiasm for commissioning works filled with complex symbolism was motivated precisely by this: it was both a flaunt of their own learning and summoning of the ideal audience.

Furthermore, this decoding process carried profound cultural significance for edification and spiritual exercise. Especially in religious subjects, symbolic symbols acted as visual tools guiding the faithful into deep meditation. For example, in paintings depicting the Madonna and Child, the rose (symbolizing love and martyrdom) or cherries (symbolizing heavenly fruit) held by the Virgin were not arbitrary embellishments but intentionally placed "signposts" to promote devout contemplation. By identifying these symbols and connecting their theological meanings, the viewer actually completed an active, personal spiritual exploration. This exploration transformed the act of viewing from passive reception into an active, almost ritualistic intellectual participation, internalizing doctrine. Similarly, in mythological themes, successfully decoding the allegory of Hercules at the crossroads between "Virtue and Pleasure" served as a reminder and tempering of the viewer's own moral character. Therefore, art appreciation in the Renaissance was a "mental exercise" requiring the mobilization of knowledge, memory, and reflection; art here functioned similarly to philosophy and literature, serving as an important means of shaping a complete personality and elevating the spiritual realm.

When we step back from the historical context and look upon this complex symbolic system and decoding practice, it can offer profound contemporary implications for our understanding of today's world of images. Firstly, it reminds us that the meaning of images is never transparent or self-evident but is highly dependent on the cultural codes of their production and the viewer's reserve of knowledge. In the age of social media, we are surrounded by a deluge of rapidly produced, often superficially encoded "flattened" images, while Renaissance painting demonstrates the immense semantic density and intellectual challenge images once possessed. This contrast prompts us to reflect: in the trend of pursuing immediate, intuitive visual stimulation, are we losing a mode of viewing and aesthetic patience that is slow, focused, and constructs meaning through deep dialogue with images?

Secondly, the pleasure of Renaissance decoding was built upon a relatively stable knowledge system shared by a specific social stratum. Today, we face a postmodern context of information explosion but fragmented consensus. The production and dissemination of symbols have become democratized and globalized, yet also fragmented and ephemeral. An emoji, a brand logo, an internet meme can all acquire powerful symbolic meaning within small groups, yet remain completely incomprehensible to outsiders. This recreates a certain function of "decoding," but its cultural foundation is no longer a unified classical or Christian tradition, but rather the fluid and ever-shifting tribes of subculture. Studying the Renaissance symbolic system can help us more clearly analyze the mechanisms of creation, circulation, and reception of symbols within various contemporary visual culture circles, understanding how images continue to shape our identity and social relations.

Ultimately, the Renaissance example teaches us that the most dynamic relationship between art and its viewer often lies within that "tacit" blank space and mutual expectation—where the artist presupposes the viewer's knowledge and dares to encode meaning, and the viewer delights in mobilizing their own abilities to decipher it, thereby attaining profound cognitive pleasure in the very act of completing the work's significance. This tacit understanding and trust between creator and recipient, grounded in shared cultural codes, stands as a defining feature of any great artistic era. In contemporary art creation and criticism, revisiting this interactive "encoding-decoding" dynamic may inspire creators to pursue deeper intellectual expression while also calling upon viewers to become more active, better-prepared participants, working together to resist the trivialization of meaning. After all, the joy that blossoms at the moment of understanding, after navigating the labyrinth of symbols, remains an undimmed beacon in the landscape of human intellectual pursuit.

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ECONOMIC SCIENCES

SOCIO-ECONOMIC DEVELOPMENT TRAJECTORIES IN AZERBAIJAN: CURRENT TRENDS AND KEY CHALLENGES

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ABSTRACT

In recent years, growing economic uncertainty, alongside the increasing visibility of environmental risks in global energy markets, has raised serious concerns about the long-term sustainability of growth models that rely heavily on natural resources. This situation has prompted countries whose revenues are largely dependent on energy to reconsider their economic structures and move toward more balanced and resilient development frameworks. Azerbaijan is among these countries, and recent developments suggest that it is approaching a significant transformation in its socio-economic development strategy.

This study aims to provide a comprehensive and integrated analysis of Azerbaijan's current socio-economic policies. The main areas of focus include efforts toward economic diversification, the digital transformation process, renewable energy strategies, and initiatives designed to enhance human capital. Within the scope of the research, reports published by national and international institutions, along with relevant academic studies, were systematically reviewed and comparatively analyzed.

The findings indicate that while Azerbaijan has achieved notable success in the oil sector, it is increasingly prioritizing investments in non-oil industries. In anticipation of the potential depletion of oil resources over the next three decades, the country is channeling its energy revenues into long-term development initiatives, recognizing energy income as a key economic pillar rather than a permanent source of growth.

The study concludes that addressing these challenges requires a strong emphasis on institutional reforms. In particular, strengthening education and employment policies, along with expanding and deepening public–private sector partnerships, is essential for ensuring sustainable and inclusive economic development.

Keywords: Socio-economic transformation, economic diversification, sustainable development, digitalization, renewable energy, human capital, Azerbaijan.

1. INTRODUCTION

The third decade of the twenty-first century stands out as a period marked by profound transformations in the global economy. The rapid diffusion of digital technologies across production and service sectors, the escalating risks associated with climate change, and the intensification of geopolitical tensions have compelled countries to reconsider their development strategies. Within this context, economies that rely heavily on revenues derived from natural resources have become increasingly vulnerable to external shocks and global fluctuations.

An examination of Azerbaijan's economic structure reveals that oil and natural gas have historically constituted the country's two primary sources of income. Although the energy sector has provided Azerbaijan with substantial and stable fiscal revenues, frequent volatility in global energy prices poses observable risks to macroeconomic stability. This situation has highlighted the limitations of a resource-dependent growth model and has encouraged Azerbaijan to pursue economic diversification and adopt a broader, more inclusive development framework. In this regard, national development strategies implemented in recent years can be interpreted as concrete steps toward restructuring the economy.

This study aims to conduct an in-depth assessment of Azerbaijan's socio-economic plans and development objectives during its ongoing transformation process. The analysis focuses on key policy areas, including economic diversification strategies, digital transformation initiatives, efforts to transition toward green and renewable energy, and programs aimed at strengthening human capital. Together, these dimensions form the core analytical framework of the study.

2. LITERATURE REVIEW

Azerbaijan's economic transformation process has been examined from multiple perspectives within the academic literature. Issues such as energy dependency, structural imbalances within the economy, and the effectiveness of institutional frameworks constitute the core themes of these scholarly discussions.

Studies focusing on economic diversification emphasize that continued reliance on oil and gas revenues may, in the long run, exert negative effects on economic stability and development. Bayramov and Abbasov argue that strengthening non-oil sectors would provide a more resilient foundation against economic fluctuations. Similarly, Hasanov highlights the manufacturing sector as a key driver of sustainable development, emphasizing its strategic role in expanding production capacity and reducing vulnerability to external shocks.

Research addressing energy transition and environmental sustainability suggests that Azerbaijan possesses considerable potential in the field of renewable

energy. Ibrahimov underlines the importance of investments in solar and wind energy as essential components for enhancing energy security and ensuring long-term sustainability. In the context of digital transformation, Guliyev notes that the expansion of e-government services has significantly improved the efficiency and accessibility of public service delivery. Memmedova, on the other hand, stresses that fostering an innovative ecosystem requires closer and more systematic collaboration among educational institutions, government bodies, and the private sector.

Studies centered on human capital development reveal that the education and training system has not yet fully adapted to the evolving demands of the labor market. Mehdiyev draws attention to the need for education policies to prioritize skills aligned with the requirements of the innovation-driven economy, emphasizing the growing importance of adaptability, technological competence, and continuous learning.

3. RESEARCH METHODOLOGY AND METHODOLOGICAL FRAMEWORK

This study adopts a qualitative research approach to provide an in-depth evaluation of Azerbaijan's ongoing socio-economic transformation process. The primary reason for choosing a qualitative methodology lies in the multidimensional and complex nature of the subject, which cannot be sufficiently explained through quantitative indicators alone. Areas such as economic diversification, digital transformation, and human capital development require a detailed examination of the gap between policy objectives outlined in official documents and the outcomes observed in practice.

The main data sources utilized in this research consist of statistical reports and official documents published by ministries of the Republic of Azerbaijan, evaluation reports produced by international organizations such as the World Bank and the International Monetary Fund, as well as peer-reviewed academic studies. These sources were selected deliberately, as they provide both policy-oriented perspectives and up-to-date empirical insights into implementation processes.

During the data collection phase, relevant documents were systematically reviewed and organized. Subsequently, a thematic analysis was conducted to identify the core analytical categories. These themes include economic diversification, digitalization, renewable energy policies, and human capital development. Information gathered from different sources for each theme was comparatively analyzed, allowing for cross-verification of findings. This approach helps to reduce the risk of one-sided interpretations that may arise from reliance on a single data source.

The methodological framework employed in this study does not aim to generate broad quantitative generalizations. Instead, it seeks to reveal the direction of current policies and the structural challenges they face in practice. In this respect, the research follows a descriptive and interpretive design, and the findings are discussed in relation to existing debates and problem areas identified in the academic literature.

4. FINDINGS AND COMPREHENSIVE DISCUSSION

The findings obtained during the course of the research indicate that one of the primary reasons Azerbaijan has not progressed at the desired pace is the presence of structural constraints that continue to hinder the socio-economic transformation process. At the same time, the results reveal that tangible progress has been achieved in several specific areas. Based on the empirical evidence, the analysis is structured around four main thematic dimensions.

Table 1

Socio-Economic Transformation Dynamics in Azerbaijan: In-Depth Analysis

Policy Dimension	Implementation-Oriented Measures	Concrete Examples and Projects	Identified Structural Challenges	Opportunities and Potential
Economic Structure Diversification	The introduction of fiscal and institutional regulatory mechanisms aimed at facilitating investment in non-oil sectors in order to reduce dependence on petroleum revenues, enhancing production capacity at the regional level, and promoting the adoption and improvement of digital-based systems in agriculture and manufacturing.	Emphasis on industrial parks, creation of special economic zones, and adoption of advanced agricultural production methods.	continued dominance of energy revenues as the primary source of public income, the insufficient level of value added generated within domestic production processes, logistical and transportation-related constraints that disproportionately affect small and medium-sized enterprises	A strategically significant regional and geographical location, a relatively young demographic structure, and the potential to integrate into income-generating trade networks at the regional and international levels.
Digital Transformation and Technological Adaptation	digitalization of public sector services and opportunities, the enhancement of	widespread accessibility of e-government services and digital public	The limited capacity of the private sector particularly	A young population with a high capacity for rapid digital adoption,

	existing electronic infrastructure, and the strengthening of individuals' technology-oriented skills.	offerings, investments in high-speed internet infrastructure, increased support for technology-driven projects.	small and medium-sized enterprises to adapt to electronic and digital technologies, shortcomings in technological expertise, existing gaps and vulnerabilities in the area of cybersecurity.	the potential for regionally targeted technological specialization, and a high level of efficiency in public service delivery.
Renewable Energy and Green Transition	The implementation of policies that promote a significant increase in energy supply from renewable resources, ensure a substantial reduction in emissions, and support practices aligned with an energy efficiency–oriented approach.	Investments focused on solar and wind energy resources, the redevelopment of reclaimed areas for environmentally friendly energy production, and infrastructure investments aimed at achieving a more efficient and resilient energy system.	The high capital and investment costs associated with renewable energy projects, existing infrastructure limitations within current energy grid, the growing need for advanced technological capabilities.	Favorable conditions characterized by long sunshine duration and strong wind resources, access to globally available green finance and investment instruments, the potential to establish a reliable and secure environment for energy production.
Human Capital and Workforce Development	The alignment of vocational education and training systems with current innovations and labor market needs, the provision of scholarships for postgraduate education, the implementation of incentives that promote research and development–oriented activities.	" The High Technology Park initiative, scholarship programs administered by the Presidential Office, support schemes and assistance programs implemented by the Innovation Agency.	The mismatch between educational outcomes and the expectations of the labor market, along with the outward migration of highly skilled individuals, commonly referred to as brain drain.	The advantages provided by a young population, a well-established educational tradition, strong support from the diaspora, and opportunities for international partnerships.

4.1. Economic Diversification Efforts

In recent years, Azerbaijan has introduced a range of support mechanisms aimed at strengthening non-oil sectors of the economy. Initiatives such as the development of industrial parks, the establishment of special economic zones, and projects designed to expand the use of technology in agriculture serve as clear examples of these efforts. Nevertheless, an examination of budget revenues and export structures indicates that energy-related sectors continue to occupy a dominant position within the economy. This persistence suggests that, despite the presence of diversification strategies, their practical impact has so far remained below the intended level.

4.2. Digital Transformation Process

Significant progress has been achieved in the implementation of digitalization-oriented policies, particularly in the delivery of public services. Investments in e-government applications and digital infrastructure have contributed to greater efficiency in administrative processes. However, the capacity of the private sector especially small and medium-sized enterprises to adapt to digital transformation has not yet reached the expected level. Limitations in digital capabilities and difficulties in accessing technology-related investments are among the key factors constraining the positive impact of digitalization on overall economic growth.

4.3. Transition Toward Renewable Energy

Azerbaijan's current position and future potential in the field of renewable energy activities and investments are clearly articulated in national strategic documents. Initiatives centered on solar and wind energy are expected to generate substantial long-term benefits in terms of sustainability. However, the existing energy infrastructure has limited capacity to accommodate the intermittent nature of renewable energy sources. In addition, one of the main factors reducing private sector interest in the energy sector is the relatively high level of initial investment costs.

4.4. Human Capital and Labor Force Dynamics

Analyses focusing on human capital development clearly indicate that the imbalance between the education system and labor market requirements continues to

persist. In particular, deficiencies in digital and technical skills represent a significant obstacle to achieving long-term development objectives. The limited retention of highly qualified human resources within the country further exacerbates these challenges and remains one of the key factors undermining sustainable socio-economic progress.

5. CONCLUSION AND DETAILED POLICY RECOMMENDATIONS

This study argues that Azerbaijan's current socio-economic transformation process is inherently multidimensional and cannot be adequately assessed through quantitative indicators alone. Policies aimed at economic diversification, digital transformation, and green energy development carry significant strategic value in achieving the country's long-term development objectives. However, the effectiveness of these policies is directly linked to the depth, coherence, and practical applicability of the structural reforms supporting them.

The findings of the study highlight the urgent need for the education system to be restructured in a way that allows it to respond more rapidly to the continuously evolving demands of the labor market. In addition, facilitating access to finance for innovation-driven initiatives and extending digital transformation beyond the public sector—particularly toward private enterprises—would accelerate the pace of economic diversification.

To ensure that the development process becomes more inclusive and effective, targeted measures should be implemented to reduce regional development disparities. Strengthening firms' operational capabilities, improving the efficient use of existing capacities, and expanding public–private partnerships are also essential steps that would contribute to sustainable growth in the long term.

In conclusion, while the strategies currently in place provide a solid foundation for Azerbaijan's long-term socio-economic progress, their success depends on consistent implementation and institutional coordination. By presenting a comprehensive assessment of the ongoing transformation process, this study aims to contribute both to the academic literature and to evidence-based policy formulation.

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THE ROLE OF WORD-OF-MOUTH MARKETING IN CONSUMER PURCHASE DECISIONS

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ABSTRACT

The primary objective for businesses to sustain their existence is to be able to continue their operations in the long term. In order to ensure this continuity, businesses must first accurately analyze the expectations and needs of their target consumer groups and offer products or services that meet these expectations and are easily accessible. Adopting an empathetic approach during the process of introducing products and services to the market is of great importance. This is because producers are also consumers, and every individual becomes a customer of a business at some point in their life. At this stage, the main goal is to strengthen customer loyalty and increase the number of loyal consumers [7].

Businesses bear significant responsibilities in this process. Various marketing methods are utilized in the promotion of products or services, with traditional and modern marketing approaches being among the most commonly used. The primary reason for this is that consumers are influenced either positively or negatively by word-of-mouth communication during their purchasing decisions. When consumers do not have sufficient time to conduct thorough research while meeting their needs, they tend to rely on the opinions and experiences of family members, friends, or people in their close social circles. Since these individuals do not seek personal gain and are easily and quickly accessible, their opinions are perceived as more trustworthy [2].

Word-of-mouth communication, which spreads in this manner and is perceived as more impartial by consumers, plays an important role today in shaping the marketing strategies of businesses. To illustrate with a simple example, no doctor prescribes mint and lemon for the treatment of the flu; however, mint and lemon have retained their value across generations and are widely accepted in society as a natural supportive remedy. This clearly demonstrates the power of information transmitted through word-of-mouth communication.

In this study titled "The Role of Word-of-Mouth Marketing in Consumer Purchase Decisions," the social, economic, and psychological factors influencing consumers during the purchasing process are examined [5].

Keywords: Word-of-mouth marketing, purchase decision, consumer behavior.

Introduction

Human beings have been communicating by sharing their emotions, thoughts, and experiences with one another for as long as humanity has existed. However, examining this form of communication from a marketing perspective has gained importance with the development of modern marketing concepts. In periods when the concept of marketing had not yet been systematically structured, businesses did not consider it necessary to establish direct communication with consumers and largely ignored interactions among consumers themselves. Today, however, the exchange of information and experiences among consumers occupies a central place in the purchasing process.

Consumption plays an indispensable role in individuals' daily lives. Consumers engage in consumption behavior not only to meet basic needs but also to gain experiences and achieve satisfaction. This behavior often results in the purchase of a product or service. During the purchasing decision process, consumers prefer to communicate with individuals whose knowledge and experiences they trust, rather than acting alone, in order to reduce uncertainty and perceived risk. This makes the impact of word-of-mouth marketing on purchase decisions more evident [4].

Increasing competition makes it progressively more challenging for businesses to communicate effectively with consumers. To attract the attention of a limited number of consumers and convert them into customers, businesses conduct intensive marketing activities. This intensity exposes consumers to numerous marketing messages daily. With technological advancements, these messages appear almost everywhere consumers are present, which over time can lead to desensitization and loss of trust. At this point, consumer opinions perceived as informal and free from commercial intent gain greater credibility [1].

While businesses aim to understand consumer expectations in their marketing activities, they also seek to leverage the power of naturally occurring communication among consumers. In this context, word-of-mouth marketing refers not to direct communication between businesses and consumers, but to the sharing of positive or negative thoughts and experiences regarding products or services among consumers themselves. Consumers wish to anticipate the potential outcomes of their decisions by benefiting from the opinions of individuals who have made similar purchasing choices before. Highly satisfied consumers not only repurchase the product but can also influence the brand perception of those around them.

Therefore, it can be argued that word-of-mouth marketing plays a stronger and more effective role in consumer purchase decisions compared to traditional advertising and other marketing tools. This form of communication, perceived by consumers as more sincere, trustworthy, and impartial, has become a decisive factor in the purchasing process. Within the scope of this study, the role of word-of-mouth marketing in consumer purchase decisions is examined, focusing on

how the information and experiences obtained from individuals' social environments affect their decision-making process [6].

Literature Review and Theoretical Frame work

Word-of-mouth marketing is defined as the process by which individuals share their experiences and opinions about products and services with people in their social environment. Research frequently emphasizes the significant impact of this form of communication on consumers' purchase decisions. In particular, when consumers lack sufficient information about a product or service, they tend to rely on recommendations and experiences from their trusted social circle. This process reduces perceived risks and enhances the sense of confidence during the purchase decision.

Various studies indicate that the effectiveness of word-of-mouth marketing is influenced by several factors. The credibility, expertise, and social connections of the person providing the recommendation strengthen the influence of the shared information on the consumer's decision. Additionally, consumers who are satisfied with a product or service not only demonstrate a higher likelihood of repurchasing but also provide positive feedback to people around them, thereby increasing brand loyalty and customer retention. Today, electronic word-of-mouth (eWOM) emerging on digital platforms has also become an effective tool in shaping online purchasing behavior.

Data from the literature suggest that word-of-mouth marketing is a more reliable and effective form of communication compared to traditional advertising and marketing methods. Consumers perceive the opinions of trusted individuals or those sharing their experiences as more sincere and convincing than advertisement messages. Therefore, word-of-mouth marketing is considered a vital strategy for businesses seeking to analyze and influence consumer behavior [5].

Methodology and Data

In this study, a questionnaire was used as the data collection method. The questionnaire consisted of a total of 33 items and was structured in three sections.

The first section included 6 items aimed at determining the demographic information of the participants. This section measured participants' gender, age, marital status, education level, occupational status, and income level.

The second section, consisting of 5 items, focused on evaluating participants' experiences in purchasing products or services through word-of-mouth marketing. In this section, participants were asked about the category of the most recent product they purchased, the closeness of the person who influenced their purchase decision, whether they shared their experiences after purchasing the product, and which source most influenced their purchase decision. The items in this section were prepared based on the study by Aydın (2009) [3].

The third section of the questionnaire included 17 items designed to measure the effects of word-of-mouth marketing on purchase decisions. The first 3 items formed a scale assessing consumers' purchase decisions, while the following 14 items were inspired by the study of Ayaydın (2019) and aimed to measure the influence of others on consumers' purchasing processes.

The last 5 items of the questionnaire were designed to examine the effect of demographic similarity on consumer decisions. Considering that the role of demographic factors in word-of-mouth marketing has not been sufficiently addressed in the literature, these items were adapted from the scale used in Mahdum's (2020) master's thesis.

This structure allows the questionnaire to reliably and comprehensively measure both the demographic characteristics of the participants and the effects of word-of-mouth marketing on purchase decisions.

Results and Discussion

The 400 data samples collected through the questionnaires used in the study were analyzed using SPSS 26 software. The analysis process began with descriptive statistics examining the demographic characteristics of the participants and their usage of word-of-mouth communication.

Next, factor analysis was conducted to identify the dimensions of the statements included in the word-of-mouth communication and purchase decision scales. This analysis aimed to investigate potential relationships between demographic variables, the sub-dimensions of the word-of-mouth communication scale, and the purchase decision dimension.

In the final stage, statistical methods were used to analyze the relationships between the purchase decision factor and the sub-dimensions of word-of-mouth communication. This process aimed to comprehensively demonstrate both the validity of the scales and the effects of word-of-mouth communication on consumer purchase decisions.

The distribution of responses to the questions asked to determine the participants' level of engagement with word-of-mouth marketing communication is presented in Table 1.

Table 1.

Participants' Usage of Word-of-Mouth Marketing Communication

Considering experience, information, advice, or opinions when purchasing goods or services	**Number**	**Percentage**
Yes	**385**	**96.3%**
No	**15**	**3.8%**
Total	**400**	**100.0%**
Product group of the last purchase made through word-of-mouth communication channel	**Number**	**Percentage**

Considering experience, information, advice, or opinions when purchasing goods or services	**Number**	**Percentage**
Cleaning Products	60	15.0%
White Goods (Home Appliances)	31	7.8%
Electronic Devices and/or Equipment	82	20.5%
Health Services	19	4.8%
Real Estate (house, car, etc.)	25	6.3%
Tourism	7	1.8%
Books/Magazines	81	20.3%
Cosmetics / Personal Care Products	86	21.5%
Other	9	2.3%
Total	400	100.0%
Relationship to the person	**Number**	**Percentage**
Family Member (mother, father, sibling)	82	20.5%
Spouse	15	3.8%
Relative	44	11.0%
Neighbor	4	1.0%
Friend	203	50.8%
Work Colleague	37	9.3%
Person met for the first time	6	1.5%
Celebrities	5	1.5%
Total	400	100.0%

Sharing positive or negative experiences with others after purchasing the product	**Number**	**Percentage**
Yes	**395**	**98.8%**
No	**5**	**1.3%**
Total	**400**	**100.0%**
The most influential source affecting the purchase decision	**Number**	**Percentage**
TV Advertisement	23	5.8%
Recommendation, information, advice	296	74.3%
Promotion	11	2.8%
Internet	59	14.8%
Other	11	2.8%
Total	400	100.0%

When participants were asked whether they purchase products by considering recommendations, information, or opinions from others, 96.3% (385 people) responded "yes," while 3.8% (15 people) answered "no." This result indicates that the vast majority of consumers make their purchasing decisions influenced by the suggestions and experiences of others.

When participants were asked about the category of the most recent product they purchased through word-of-mouth communication, the distribution was as follows: 15.0% (60) cleaning products, 7.8% (31) white goods, 20.5% (82) electronic devices, 4.8% (19) health services, 6.3% (25) real estate (house, car, etc.), 1.8% (7) tourism, 20.3% (81) books or magazines, 21.5% (86) cosmetics or personal care products, and 2.3% (9) other categories. Among those who selected "Other," six participants indicated clothing products, while three did not specify any category.

When asked about their closeness to the people from whom they received recommendations, information, or opinions and with whom they shared their experiences, the responses were distributed as follows: 20.05% (80) family members, 3.8% (15) spouse, 11.0% (44) relatives, 1.0% (4) neighbors, 50.8% (203) friends, 9.3% (37) colleagues, 1.5% (6) people met for the first time, and 1.5% (5) celebrities.

When participants were asked whether they shared their positive or negative experiences after purchasing a product or service with others, 98.8% (395 people) responded "yes," while 1.3% (5 people) answered "no." This finding shows that the majority of consumers share their post-purchase experiences with their social circles.

When participants were asked which source most influenced their purchase decision, the distribution of responses was as follows: 5.8% (23) television advertisements, 74.3% (296) recommendations, information, or opinions, 2.8% (11) promotions, 14.8% (59) the internet, and 2.8% (11) other sources. This result reveals that word-of-mouth communication is the most influential source on consumer purchase decisions [2].

Conclusion

This study examined the effects of word-of-mouth marketing on consumer purchase decisions, and the findings demonstrate that this form of communication plays a decisive role in consumer behavior. According to the research results, consumers place significant trust in recommendations, information, and experiences received from their close social circles when purchasing products or services. In particular, information coming from personally close sources such as family, friends, and relatives positively shapes purchase decisions and reduces perceived risk. Furthermore, consumers sharing their purchase experiences with others has an important impact on the credibility and spread of the product or service.

In this context, it is critical for businesses to emphasize word-of-mouth marketing strategies when developing their marketing plans, as this approach can both increase sales and strengthen consumer loyalty. By disseminating trustworthy and effective messages through individuals close to consumers, businesses can reach their target audience and positively influence purchasing decisions. In conclusion, word-of-mouth marketing is shown to be a more reliable, effective, and sustainable communication method compared to traditional marketing tools, and it should be utilized as a strategic instrument in modern marketing strategies.

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REGULATORY MECHANISMS FOR STIMULATING INVESTMENT IN INNOVATION AND STARTUPS

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ABSTRACT

In the context of modern economic transformation, the expansion of digital technologies and the rise of knowledge-based models have positioned the innovation and startup sector as a key driver of sustainable development. In this regard, the legal support of the innovation environment and the promotion of startup activity play a central role not only in economic growth but also in ensuring technological resilience. Stimulating investment, providing tax incentives, legal transparency, and protecting investor rights are essential prerequisites for sectoral development.

In Azerbaijan, although significant steps have been taken in recent years to establish a legal framework for innovation and startup activity, the existing normative base remains fragmented and inconsistently implemented. Instruments such as the "Startup Certificate" are present in legislation, but their broader application, the development of mechanisms ensuring legal protection for investors, and the adaptation of international experience remain key challenges.

This paper explores the legal status of innovation and startup activity within national legislation, analyzes the current investment promotion mechanisms, and evaluates the legal regimes of technoparks and innovation zones. The study also examines how investor rights are protected and proposes specific legal reforms based on global best practices. The findings highlight that the development of the innovation sector requires not only economic tools but also a robust legal foundation and strong institutional support.

Keywords: Innovation law, startup companies, investment incentives, tax exemptions, legal framework, technoparks, startup certificate, innovation policy, institutional support, investor rights.

Introduction

1. Innovation and startup concepts – analysis of the legal and economic framework

The innovation and startup sector is considered one of the main driving forces of economic growth, technological innovation and job creation in the modern era. This sector creates flexible and dynamic changes in the structure of the economy, especially in countries where digitalization and knowledge-based economies are developing. However, the legal and economic framework of this field of activity varies from country to country and often directly affects its development pace.

In the Republic of Azerbaijan, the concept of "startup" has only begun to be included in the legislation from a legal perspective in recent years. Although this term was previously used informally, in 2018, with the amendments made to the Tax Code, the "Startup Certificate" was adopted as a legal term. This document provides certain tax benefits to micro and small business entities engaged in innovation-oriented activities. Individuals who receive a startup certificate are exempt from income and profit tax for a certain period of time.

However, the concept of "startup" has not yet been systematically and comprehensively defined in Azerbaijani legislation. This gap can lead to legal uncertainty for investors and sometimes the inability to use state support mechanisms. For example, there are no unanimous and normatively regulated criteria for whether a project is considered a startup.

Innovation activity is a broader concept and includes activities such as commercialization of scientific research results, application of technologies and launching of new products on the market. However, a special Law "On Innovation" for this type of activity has not yet been adopted in Azerbaijan. This leads to the fact that legal and institutional support is managed with administrative approaches rather than a fragmented and normative basis.

The role of innovation and startups in the Azerbaijani economy is growing. Figures provided by the State Statistics Committee and the Ministry of Economy show that the number of startups in the fields of information technology, agrarian technologies, fintech and energy has increased significantly in recent years. However, the breadth and flexibility of legal mechanisms to support this development are still not at the desired level.

Legal protection of intellectual property is also of great importance in this area. Startups face greater risks when new products, software and technical inventions lack legal protection at an early stage. Patent and copyright mechanisms are still not fast and effective, which reduces investment attractiveness.

The result of this focus is that the legal basis of the innovation and startup sector must be strengthened not only with incentive documents, but also with a unified legislative framework, institutional transparency, and clear protection of investor rights. Only then will it be possible to build a real and sustainable innovation ecosystem.

Methodology

This study employs a **qualitative and comparative research methodology** to analyze the legal framework for stimulating investment in the innovation and startup sector, with a particular focus on Azerbaijan. The methodological approach is designed to assess the effectiveness of existing legal instruments, identify structural gaps, and propose policy-oriented legal reforms based on international best practices.

First, a **document and legal analysis** method is applied. National legislative acts of the Republic of Azerbaijan, including the Tax Code, the Law on Investment Activity, regulations related to startup certificates,

and technopark incentive mechanisms, are systematically reviewed. This analysis focuses on the scope, clarity, and practical applicability of legal norms regulating startup activities, investment protection, and innovation incentives. Special attention is paid to identifying legal ambiguities, overlaps, and enforcement challenges affecting startups and investors.

Second, a **comparative legal analysis** is conducted to benchmark Azerbaijan's legal framework against international experiences. The legal and institutional models of Estonia, Israel, and selected European Union countries are examined, emphasizing simplified regulatory regimes, digital governance mechanisms, investor protection instruments, and intellectual property registration procedures. Reports and policy documents from international organizations such as the OECD, UNCTAD, the European Commission, and WIPO are used to identify globally recognized standards and effective legal practices.

Third, the study utilizes a **analytical approach** to evaluate the institutional environment supporting innovation and startups in Azerbaijan. Official reports from the Ministry of Economy and the State Tax Service are analyzed to assess the implementation of startup certificates, technopark policies, and fiscal incentives. This approach enables the identification of bureaucratic barriers, administrative inefficiencies, and institutional coordination issues affecting the sector.

In addition, the research incorporates a **systemic approach**, viewing the startup and innovation sector as an interconnected legal, economic, and institutional system. This perspective allows the study to assess how legal regulations interact with taxation, intellectual property protection, digitalization, and investor confidence.

Finally, the findings of the legal and comparative analyses are synthesized to develop **policy-oriented recommendations**. These recommendations focus on the feasibility of adopting a unified law on startup and innovation activities, improving digital registration and licensing systems, strengthening investor legal protection, and enhancing the

Literature Review

The development of an effective legal framework for stimulating investment in innovation and startup sectors has become a key policy priority for both developed and developing economies. Legal regulations, fiscal incentives, institutional support mechanisms, and intellectual property protection jointly shape the investment climate for startups and innovative enterprises.

From a national legal perspective, the **Tax Code of the Republic of Azerbaijan** (2023) establishes a foundational mechanism for encouraging startup activity through tax exemptions and preferential regimes for certified startups. These provisions aim to reduce the financial burden on early-stage innovative firms and enhance their investment attractiveness. Complementing this, the **Law on Investment Activity** of Azerbaijan defines innovation as an object of investment, providing legal clarity and protection for both domestic and foreign investors. According to the **State Tax Service of the Republic of Azerbaijan** (2021), the introduction of the startup certificate has played a significant role in formalizing startups and granting access to tax and regulatory incentives, although practical implementation challenges remain.

Institutional support policies are further analyzed in the **Ministry of Economy's official report** (2022), which highlights the role of technoparks, innovation centers, and public–private partnerships in fostering an innovation-friendly legal environment. Aliyev (2022) critically evaluates Azerbaijan's current innovation-related legal framework and emphasizes the need for regulatory simplification, stronger investor protection, and clearer enforcement mechanisms to stimulate private investment in startups.

International experience provides important comparative insights. The **European Commission** (2021) presents a comparative framework of startup and innovation policies across Europe, demonstrating that countries with coherent legal systems, stable regulatory environments, and targeted fiscal incentives tend to attract higher levels of venture capital. Similarly, the **OECD** (2020) emphasizes that well-designed legal frameworks—particularly those supporting access to finance, competition, and entrepreneurship—are critical for startup development in emerging economies. **UNCTAD** (2022) reinforces this view by proposing an innovation policy toolkit tailored for developing countries, stressing the importance of regulatory coherence, institutional coordination, and legal certainty.

Country-specific best practices further illustrate the role of law in startup development. The **Estonian e-Residency and Startup Visa frameworks** (2021) demonstrate how digital legal infrastructure and simplified administrative procedures can attract foreign entrepreneurs and investors. The **Israel Innovation Authority** (2022) showcases a legal and institutional model based on strong intellectual property protection, targeted state support, and close collaboration between government, academia, and private investors. These examples underline the importance of adaptive legal systems in stimulating innovation-driven investment.

Theoretical and legal scholarship also contributes to understanding startup investment regulation. Giudici, Agstner, and Capizzi (2022) analyze the corporate design of startup investments in Europe, emphasizing the role of governance structures, shareholder rights, and contractual flexibility in protecting investors. Kroitor (2023) discusses legal principles of venture investment, arguing that effective startup legislation must balance investor protection with entrepreneurial flexibility. Porokhniak (2024) highlights state policy instruments such as grants, guarantees, and tax incentives as essential legal tools for encouraging innovation-based economic activity.

Comparative legal analysis is particularly relevant for transition economies. The study *The Legal Bridge between Startup and Investor* (2025) compares Azerbaijan and the United States, identifying differences in regulatory maturity, venture capital law, and enforcement mechanisms. The findings suggest that while Azerbaijan has made progress in formal regulation, further alignment with international best practices is needed to strengthen investor confidence.

Related empirical studies by Huseynova and co-authors, although focused on education, food security, marketing, and financial regulation, indirectly support

the importance of human capital development, institutional trust, and regulatory stability for innovation ecosystems (Huseynova, 2019; 2023; Sara & Nurlana, 2024; Huseynova & Balajayeva, 2025). These studies provide a broader socio-economic context in which startup investment regulation operates.

Finally, intellectual property protection remains a core component of the legal framework for innovation. The **World Intellectual Property Organization (WIPO)** (2023) emphasizes fast-track patent systems and startup-oriented IP mechanisms as critical for safeguarding innovations and attracting venture capital.

Overall, the literature demonstrates that stimulating investment in the innovation and startup sector requires an integrated legal framework combining tax incentives, investment protection, institutional support, intellectual property rights, and regulatory transparency. While Azerbaijan has established an initial legal and institutional base, comparative international evidence suggests that continuous legal reforms and effective implementation are essential for fostering a dynamic and investment-friendly startup ecosystem.

Legal instruments and incentive mechanisms for stimulating investments

One of the main issues in the development of the startup and innovation sector is the stimulation of investments aimed at this area. To encourage capital flows, states mainly rely on tax breaks, legal simplification and institutional support mechanisms. In the Republic of Azerbaijan, certain legal instruments have been created in this area in recent years and incentive mechanisms have begun to be applied.

One of the most important legal instruments is the **“startup certificate”**. According to Article 102.1.22 of the Tax Code of the Republic of Azerbaijan, legal entities and individuals who obtain this document are exempt from income and profit tax for a period of 3 years. This incentive mechanism not only reduces the financial burden at the initial stage of innovative activity, but also reduces the risk for investors. However, the somewhat bureaucratic nature of the application and approval procedures for using these benefits can limit the effectiveness of this tool.

Another important mechanism is the legal regime of technoparks and innovation zones. A number of technoparks (for example, High Technology Park) operate in the Republic of Azerbaijan. Residents registered in these zones can benefit from a number of tax and customs benefits. For example, customs duty exemptions are applied for the import of equipment and technological devices. In addition, technopark residents can also be exempted from income tax and land/tax fees.

Startup funds and incubator programs to support innovation activities are also envisaged within the framework of legal regulation. These structures provide both financial and legal advisory services. However, in Azerbaijan, the forms of these funds operating with state support are more prevalent and their independent, investor-oriented legal framework is not extensive. This also makes it difficult for direct foreign investors and venture capital institutions to enter.

Public-private partnership (PPP) mechanisms play an important role in legal incentives. Within the framework of the Law “On Public-Private Partnership” adopted in the Republic of Azerbaijan in 2023, it has become possible for startups to participate in PPP models in certain areas (especially energy and technology). This creates new opportunities both in terms of sharing the risk of innovation and legal security.

Legal mechanisms for the promotion and protection of investors should not end with the application of concessions. The security of their investments, the legal force of contracts and the right to arbitration should also be ensured by legislation in a clear and transparent manner. Although the current Azerbaijani legislation provides certain guarantees for foreign investors, the lack of specific legal mechanisms for technology-oriented startups creates a legal gap in this area.

In conclusion, while the existence of legal instruments is a positive indicator, the simplification, flexibility, and effectiveness of institutional implementation mechanisms of these instruments are key factors that will have a real impact on the sector.

3. Recommendations in light of legal challenges and international experience

Although Azerbaijan has established a legislative framework to develop the innovation and startup sector, legal challenges in this area limit the sustainable development of the sector. The main problems are the fragmented regulatory framework, uncertainty of investor rights, the complexity of the legal registration process, and difficulties in the practical application of state support.

First of all, the lack of a unified and comprehensive definition of the legal status of startups creates a serious gap in the legislation. Currently, the “startup certificate” is used only for tax purposes, and the technical and legal criteria for obtaining this document are sometimes unclear. This creates an unstable legal environment for both investors and startup founders.

The second important challenge is related to the state registration process of startups. The procedures for registering a new legal entity and approving innovative activities often take a long time. In some cases, the lack of coordination between different state bodies slows down this process. In foreign practice, in particular in Estonia and Singapore, “e-residency” and online registration models are applied. These models are an important example in terms of legal simplification and elimination of bureaucracy.

The third issue is related to the protection of investor rights. Legal stability, freedom of contract, fair dispute resolution, and access to international arbitration mechanisms are important for investors, especially foreign investors. Although Azerbaijan has joined certain international conventions in this area, there are no separate protection mechanisms for technological and high-risk types of investments.

The fourth problem is related to the enforcement of intellectual property rights. Startups' innovative products often start at the idea level and need legal protection. However, the patent and copyright registration system in Azerbaijan is complex in terms of both time and procedure. This creates serious risks in protecting technology-based startups.

As a recommendation, Azerbaijan can take the following legal steps in this area:

1. Preparation and adoption of a separate law "On Startup and Innovation Activities";
2. Creation of a single legal regime for technoparks and innovation zones;
3. Implementation of electronic registration and e-license systems;
4. Separate regulation of investor rights regarding startup investments (venture capital, immunity zone, etc.);
5. Rapid registration and protection mechanisms of intellectual property in line with international practice.

As a result, overcoming legal challenges is possible not only through regulatory amendments, but also through real implementation opportunities, institutional coordination, and the creation of an investor-friendly legal environment.

RESULT

The innovation and startup sector, as one of the main pillars of modern economic development, serves not only to introduce new technologies, but also to increase the competitiveness of the economy, create new jobs and expand export potential. However, for this sector to function effectively, not only economic incentives but also a strong, transparent and flexible legal framework are necessary.

The study finds that while there are some legislative initiatives in Azerbaijan in the field of startups and innovation, these initiatives have not yet been transformed into a systematic legal mechanism. While tools such as startup certificates and technopark incentives are useful, their implementation is fraught with bureaucratic obstacles and legal uncertainties. Lack of clear definition of legal terms, insufficient protection of investor rights, and slow registration of intellectual property can reduce confidence in the sector.

International experience shows that the more predictable and simple the legal environment, the stronger the investor flow. In countries such as Estonia, Israel, and South Korea, simplified legal regimes, e-government mechanisms, and special investor protection packages have ensured the rapid development of the startup sector.

In this regard, the adoption of a single law "On Startup and Innovation Activities" in Azerbaijan, the digitalization of registration and licensing procedures, the strengthening of legal protection for startups for investors, and the flexibility of the intellectual property system will be key conditions for the long-term development of the sector.

Discussion.

The findings of this study confirm that the innovation and startup sector plays a strategic role in enhancing economic competitiveness, employment generation, and export diversification. However, the effectiveness of this sector is closely linked not only to financial incentives but also to the quality and coherence of the legal framework governing innovation and investment activities.

The analysis reveals that Azerbaijan has taken important initial steps toward supporting startups through instruments such as startup certificates, technopark regimes, and selective tax incentives. Nevertheless, these measures remain fragmented and have not yet evolved into an integrated legal system. This fragmentation limits the predictability of the regulatory environment and increases legal uncertainty for both entrepreneurs and investors. As highlighted in the findings, unclear legal definitions, overlapping regulations, and procedural complexity undermine the practical effectiveness of existing legislative initiatives.

A critical issue identified in the discussion is the insufficient protection of investor rights within the startup ecosystem. Weak contractual safeguards, limited dispute resolution mechanisms, and inadequate enforcement of investment-related legislation reduce investor confidence, particularly for foreign venture capital. In parallel, delays in intellectual property registration weaken the ability of startups to protect innovative ideas, thereby reducing their valuation and attractiveness to potential investors.

The comparative analysis with Estonia, Israel, and South Korea demonstrates that successful startup ecosystems are built on simplified and transparent legal regimes. These countries have implemented digital registration systems, fast-track licensing procedures, and strong investor protection mechanisms, significantly reducing transaction costs and administrative barriers. The presence of specialized startup legislation in these countries also provides legal clarity, harmonizes regulatory norms, and ensures consistent policy implementation.

The discussion further suggests that Azerbaijan's current legal framework lacks sufficient flexibility to adapt to the rapidly changing nature of innovation-driven activities. In contrast, international best practices emphasize adaptive regulation, continuous legal updates, and close coordination between government institutions, innovation agencies, and the private sector. This adaptability enables legal systems to respond effectively to technological change and evolving investment models.

Based on these findings, the proposed adoption of a unified Law "On Startup and Innovation Activities" could serve as a cornerstone for legal reform in Azerbaijan. Such legislation would consolidate existing norms, define key legal concepts, strengthen investor protections, and institutionalize digital registration and licensing processes. Additionally, enhancing the flexibility of the intellectual property system would align national regulation with international standards and support long-term innovation-led growth.

Overall, the discussion highlights that legal reform is not merely a supporting measure but a central determinant of startup sector development. Without a predictable, transparent, and investor-oriented legal framework, financial incentives alone are insufficient to ensure sustainable growth of the innovation ecosystem in Azerbaijan.

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HISTORICAL SCIENCES

THE ACTIVITY OF THE AZERBAIJAN CREATIVE UNIONS IN THE FIELD OF PROPAGANDA IN THE 60 – 80s OF THE XXth CENTURY IN THE SCIENTIFIC WORK OF PROFESSOR NISBET MEHDIYEVA

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ABSTRACT

Azerbaijan has always been known all over the world for its outstanding representatives, invaluable intellectuals, scientific and cultural figures, educators and scientists who have made the great contributions to the development of education and science, talented researchers who have worked extensively and effectively in various fields of science, personalities who have risen to the highest peaks of science, and eternally young and eternal sons and daughters. These individuals have been specially selected for their intense and tireless activity in the continuous development of Azerbaijan science and have always been distinguished by their uniqueness. One of the prominent intellectuals of Azerbaijan historical science, Doctor of Historical Sciences, Professor and outstanding historian Nisbet Mehdiyeva, has courageously stepped into very difficult fields of science and conducted major researches. In the research works dedicated to the creative work done and carried out by Professor Nisbet Mehdiyeva in the field of activity and propaganda of the Azerbaijan Creative Unions, the activity of these organizations in the development of culture in our country in the 1960 – 1980s, the exposure of talented and creative individuals, the promotion of the scientific potential of each individual, the improvement of the general cultural level of the people and the population, the creation of a business and creative environment for talented and truly capable individuals engaged in creative activities, the involvement of the country`s prominent intellectuals in this creative process, the formation of a sound and correct policy of the state in the field of cultural development and other topical issues were extensively studied and found their worthy scientific solution as a result of the great efforts of the scientist. Professor Nisbet Mehdiyeva`s intense, highly creative and productive scientific activity in this field is undeniable. The researches conducted by Professor Nisbet Mehdiyeva in the field of the activity of Creative Unions engaged in artistic creation in the formation of the general cultural level of society, also its basing on the national – moral values of Azerbaijan and the most perfect scientific and cultural examples of the world, should be considered the great creative success.

Keywords: Azerbaijan, Creative Unions, propaganda, Professor Nisbet Mehdiyeva, scientific creativity, historical science, intellectual, activity.

İntroduction

One of the characteristic features of the modern era is that it includes decisive means ans ways to shape, encourage, develop, direct and promote the activity of people in the political, economic and cultural spheres, and to develop and implement the necessary action plans for this purpose. Thus, the development of all these areas is directly connected in the developing and promotion of culture. From this point of view, the complex development of culture means the gradual maturation, development and formation of areas directly or indirectly related to it. The state`s concern for the development of professional and amateur creativity, despite the difference between the professional creativity, distinguished by its uniqueness, has its own path, has mastered all its subtleties in this field, and has become the more prepared cadre over time, and amateur creativity, which is still opening new paths and trying to speak its mind, it is quite remarkable that both are given a place in the society, promoted and encouraged. The activities carried out by the Creative Unions in the field of promoting works of art take an important part in this work [4, 3].

The activity of the Creative Unions in the field of propaganda

When it comes to propaganda, organizational measures, forms and methods of writing works, mass propaganda, its organization and other theoretical and practical aspects should be taken into account. The establishment of propaganda bureaus and department is envisaged as organizational measures. The activity of propaganda bureaus includes the organizing meetings of creative intellectuals with people, organizing readers` and audience conferences, holding debates and other mass cultural events, organizing the activity of people of various creative professions in the field of propaganda, developing a work plan with people of different age categories, building a moral bridge between creative intellectuals and readers and audiences, forming the ideological, moral and aesthetic education of society and other theoretical and practical measures.

Through the propaganda bureaus, the series of important events, such as the regular meetings, events, round tables, disputes, discussions, debates and etc. have been held between the creative intellectuals and readers and viewers in the country. In this context, the creation of new works, the development of creative forms and methods, the holding of discussions of beatiful examples of art and works that are the products of the artistic imagination of creative intellectuals, the

identification of creative searches and etc. can be considered as the main directions of propaganda. At the same time, the main spheres of propaganda are reading lectures, participating in the work of cultural universities, regularly holding poetry days and weeks, providing patronage for the organization of cultural events and the activity of the creative organizations, organizing the practical work with cultural and educational institutions, caring for the development of artistic creativity, showing exhibitions, promoting music, organizing the festivals on a regular basis, promoting theater performances, cinema – propaganda, discussing and showing films, taking scenarios from real life events and basing them on real facts, making feature and documentary films, etc. In 1973 alone, the Union of Artists of Azerbaijan and the Ministry of Culture of Azerbaijan jointly organized 100 exhibitions [16]. However, it should also be noted that, along with these literary and artistic works that reflect serious social and moral problems, real facts, important issues, and episodes arising from the real life of the country and people, it is also possible to come across works that are banal, weak, and written and created to please someone. At the same time, demonstrating the principle position in the activity of the creative unions, responsibility, demandingness, care for talent, preventing their destruction and elimination by all means, both by the state, citizens and creative organizations, should be considered one of the most important and necessary tasks facing the country`s creative intellectual environment. From this point of view, in the creation of all literary and artistic works and various examples of art, characteristics such as honesty, humanity, humanism, art and science, and responsibility towards the country have been guided, and the citizen, creative intellectual has always approached the events taking place in the country, the current socio – political situation, the state of the country, and the negative situations and shortcomings we encounter in our daily lives from this prism, from the citizen`s perspective, and has always gone his own way and tried to have his say. In this regard, the extensive research works conducted in this field by the historian, great educator, and lifelong intellectual, Professor Nisbet Mehdiyeva [İmage 1], as well as the current issues she raises and the beautiful research works that always resonate with reality and defend the supremacy of truth and justice, are quite remarkable.

Image 1. Doctor of Historical Sciences, Professor Nisbet Mehdiyeva

Professor Nisbet Mehdiyeva`s textbook “The activity of the Azerbaijan Creative Unions in the field of mass propaganda (1960 – 1980s)” [4], her book “The cultural relations of the Azerbaijan Creative Unions (1960 – 1980s)” [5], her monograph “The activity of the Azerbaijan Creative Unions in the field of the development of culture (1960 – 1980s)” [3] and other works are quite noteworthy in this regard and should be considered the fundamental research works in studying the activity of the Azerbaijan Creative Unions.

Professor Nisbet Mehdiyeva`s textbook “The activity of the Azerbaijan Creative Unions in the field of mass propaganda (1960 – 1980s)” [Image 2] is dedicated to the mass propaganda activity of the Azerbaijan Creative Unions in the field of widely distributing the works of literature and art using the various forms and methods. The events, exhibitions, festivals, screening of theater and cinema works and other important points carried out by the creative intellectuals in the field of promotion of artistic culture are covered in detail.

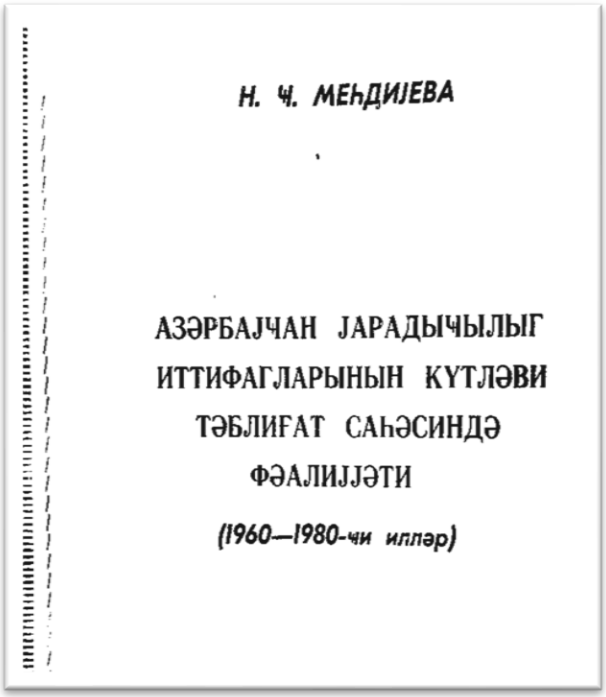

İmage 2. Professor Nisbet Mehdiyeva`s textbook "The activity of the Azerbaijan Creative Unions in the field of mass propaganda (1960 – 1980s)" (1990)

Professor Nisbet Mehdiyeva`s book "The cultural relations of the Azerbaijan Creative Unions (1960 – 1980s)" [Image 3] reflects the activity of the Azerbaijan Writers` Union in the republic in the field of literary translation, promotion of literature, relations in the field of literary and cultural events and other important creative aspects. The book examines and explains in detail the multidisciplinary relations between the Unions of Composers, Artists, Cinematographers, the Theater Society and the "Azerbaijanfilm" studio through the works of music, painting, theater and cinema. The book also highlights the aspects such as the mutual implementation of these relations with relevant unions and organizations in the country and abroad. In addition, Professor Nisbet Mehdiyeva put forward the certain proposals in the book to improve the forms and methods of cultural relations of the Azerbaijan Creative Unions, increase their efficiency and made the number of recommendations to eliminate shortcomings occurred during the creative process. The valuable scientific work and extensive activity carried out by the researcher in this field can be considered the product of the great scientific researches of the valuable scientist, based on real facts and practical activity.

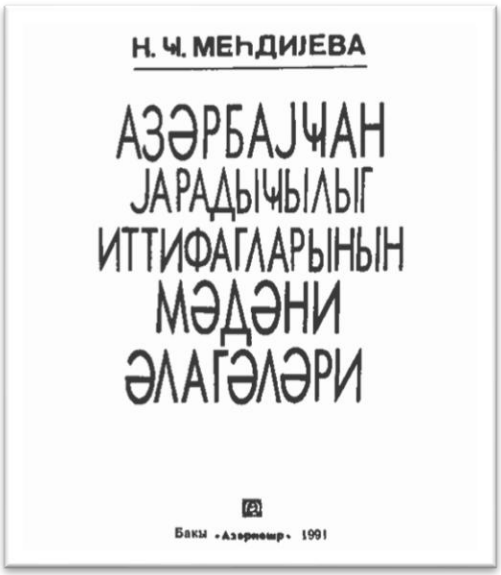

İmage 3. Professor Nisbet Mehdiyeva`s book "The cultural relations of the Azerbaijan Creative Unions (1960 – 1980s)" (1991)

Professor Nisbet Mehdiyeva`s monograph "The activity of the Azerbaijan Creative Unions in the field of the development of culture (1960 – 1980s)" [Image 4] reflects the issue of the activity of the Writers` Union, Composers` Union, Artists` Union, Theater Workers` Union and Cinematographers` Union in the field of the development of culture in Azerbaijan historiography. The author has extensively researched the ideological and political level of creative intellectuals in the country, their professional skills, the creative and organizational work of unions, their role in the promotion of artistic culture and their activity in the field of cultural relations. This research work by Professor Nisbet Mehdiyeva is of great interest. The activity of the Creative Unions is very diverse, significant and unique, and reflects the various cultural issues. These creative organizations, engaged in purely creative and artistic activity, take an important part in raising the cultural level of the people. The researcher, Professor Nisbet Mehdiyeva, in addition to dedicating space to the achievements and successes gained in the process of explaining and investigating each issue, also noted the shortcomings and mistakes made, indicating the need to develop an important practical action plan to eliminate them.

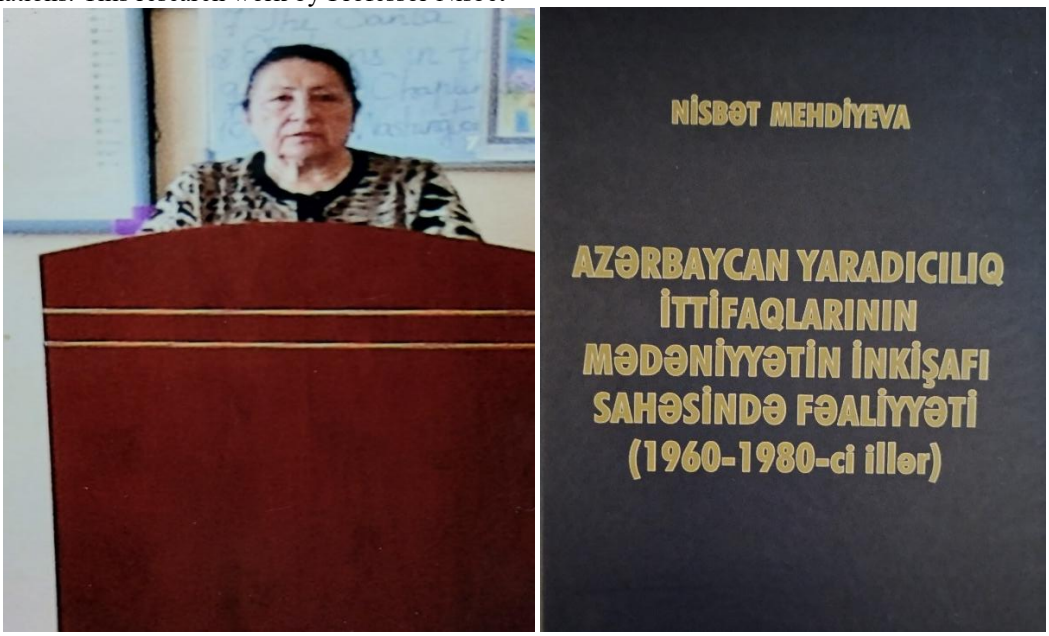

İmage 4. Professor Nisbet Mehdiyeva and her monograph "The activity of the Azerbaijan Creative Unions in the field of the development of culture (1960 – 1980s)" (2014)

In our country, the part of the Creative Unions in the implementation, organization and formation of cultural education work and other spheres is unique. In the effective implementation of this activity of the Creative Unions, the role of the Propaganda Bureau and Club, Exhibition Hall, Art Gallery, Composers` House, Cinema House, Actors` House, etc. should be especially noted. Thus, the Bureau of Literary Promotion was established for writers, the Exhibition Hall for artists, and the Bureau for the Promotion of Music under the Union of Composers. The Exhibition Hall, established in 1960, was transformed into the Azerbaijan State Art Gallery in 1974 [4, 6; 2].

The department promoting the cinematography began operating under the Azerbaijan Cinematography Workers` Union in 1962. This department regularly held wide – ranging lectures, creative meetings and various events [13].

In the promotion of literary and artistic works, it is necessary to specially mention the part and activity of the organs of the Writers` Union, the newspaper "Literature and Art", the magazines "Azerbaijan", "Ulduz", "Gobustan", "Literary Azerbaijan", as well as the various press agencies of the republic [4, 10].

The television and radio, which are mass media, were also widely used in the promotion of fine arts. The twenty special programs related to the individual and general exhibitions of artists and the dozens of short films were shown on television. The Union of Artists also actively promoted through publishing houses and periodicals. The color albums, pictures, sets of artistic postcards and etc. containing the works of Azerbaijan artists were released. The works and catalogs about the artists were also published. The artistic life of the republic, innovations in the creative environment and etc. were covered in the newspapers and magazines [10].

The cinema was also widely promoted through the televizion programs. Every month the television program called "Writer and screen" was organized on television. These programs discussed the current problems of screen adaptation of the literary works, the mutual relations between literature and cinema, the introduction of the best examples of literary works, the works of art that emerged as a result of the search for new plots and ideas and etc. [18, 11 – 12, 18].

Professor Nisbet Mehdiyeva has shown that in the 60 – 80s of the 20th century, the Creative Unions of the Republic of Aerbaijan were constantly searching for new forms in the field of increasing the educational significance of literary and artistic works. According to the researcher, one of such forms was the activity of music lectures, discussion of the works, conferences of readers and spectators, holding of the various disputes, etc. The purpose of holding these events was to establish

direct contact with a wide audience of listeners, spectators and readers, to hold creative discussions and exchange of ideas.

In 1960, the members of the Union of Artists of the Republic gave 85 lectures. These lectures were brought to the attention of readers, listeners and spectators at the events held in the various departments and organizations, military units, border regions, cultural centers, officers` houses, art museums and etc. 6.000 people attended these events [8; 12]. In 1962, the members of the Artists` Union gave 102 lectures. The geographical map of the lectures organized each year was quite extensive [4, 23].

The Bureau of Fiction Promotion of the Writers` Union in the republic organized 27.563 meetings of writers in 1970 – 1975. For about 200 writers participated in these meetings. Most of these meetings were devoted to individual reports, lectures, disputes, discussions, creative reports, discussion and analysis of new creative forms and methods, meetings and events in the form of questions and answers with readers, round tables, various interviews, evaluation of creative activity and determination of directions, etc. [4, 24]. The researcher drew the special attention to these issues and emphasized their importance.

In the 70s of the 20th century, the Azerbaijan Theater Society, guided by the theme of effective use of the lecture – propaganda tool, organized 596 lectures on the problems of theater art in the various cities of the republic in just 6 years. The topics of these lectures were "Realism in Theater", "Modern Reading of Classics", "Actor in the Puppet Theater", etc. Thus, the lectures on these topics were aimed at familiarizing the audience with the problems of theatrical art, theater repertoires and artistry issues, the problem of the actor and the stage in 20th century theater, modern theater through the eyes of the audience, aspects of theater and realism, the formation of theatrical vision, the place of theater in modern life, the establishment of the concept of actor and audience, the reflection of real – life facts and events in theater, etc. issues were aimed at solving, analyzing and realistically staging them [14].

Professor Nisbet Mehdiyeva notes that the Propaganda Bureau of the Union of Cinematographers of Azerbaijan organized 440 lectures on the promotion of cinematography almost every year [19, 10]. According to the researcher, these lectures organized by the Creative Unions of the Republic were delivered by literary critics, theater critics, art critics, music critics and film critics. Professor Nisbet Mehdiyeva also indicated that the art critics and critics working and specializing in the relevant arts were also involved in this work [4, 25].

These various forms of propaganda, each functioning in its own unique way, played the decisive role in the cultural and aesthetic education and formation of the taste of the population.

The poetry days, painting days, literature and art weeks, which were regularly held by the Creative Unions, also played the important role in the promotion of works of art. The poems read at the poetry days held annually by the Writers` Union were later published in the separate books [4, 30].

On the Artist`s Day, held by the Union of Artists of the Republic from April 1 to 16, 1961, 8 exhibitions were opened, 4 reports were read, 10 talks were organized, and 15 meetings were held. In this regard, 7 radio and 9 television programs were prepared and broadcast, and articles were published in the newpapers. In this series, "Artist`s Day" was also held in the cities of Baku, Sumgayit, Ganja and Neft Dashlar, where the professional artists, art historians, critics and other creative intellectuals participated [9].

The literary and cultural relations

The Azerbaijan Creative Unions were closely involved in the international relations. According to the researcher, the forms and means of these relations are rich, the scope is wide, the geography is boundless and the importance is great. At the meetings held in the Creative Unions, international cultural relations, translation problems, discussions, disputes, interviews, the role and place of international relations in the formation and development of the creative environment, various creative issues and problems and other aspects were given wide space [5, 5].

The prominent researcher notes that the forms and methods of relations between the Azerbaijan Creative Unions and institutions and organizations engaged in the publication, exhibition and promotion of literary and artistic works of various countries are quite diverse. The acquaintance, learning, establishing contacts, exchange, development and other forms and methods occupied the important place in the activity of these organizations [5, 7].

The work done to study the international cultural relations of the Azerbaijan Creative Unions, the collected materials and facts are diverse and valuable. Thus, their writing, analysis and formulation are extremely necessary. The international relations of the Creative Unions mainly covered the issues of literary – cultural relations and cooperation in the field of art.

The mutual influence and enrichment in the field of cultural relations is one of the important issues and is always highlighted by its relevance. The mutual national enrichment and cultural cooperation play the important role in establishing and strengthening international relations. The cultural heritage of peoples and their progress in this field are also manifested through the cultural relations.

The main activity of the Azerbaijan Writers` Union in the field of international cultural relations was literary translation and promotion of lterature. The researcher considers that this is why the Union had the translation department [3, 199]. The translation and publication of a number of works into Azerbaijanian language, and examples of Azerbaijan literature into the various languages of the world, as well as the publication of translations of prose, poetry and drama in literary publications, could be considered one of the most important issues facing the Writer`s Union [3, 200, 201]. In the 60s and 70s of the XXth century, the works of more than 100 Azerbaijan artists – a total of about 500 books – were translated into the languages of Russian, Ukrainian, Belarusian, Georgian, Latvian, Estonian and other peoples [3, 206].

The literary and cultural relations of the Azerbaijan Writers` Union included the cooperation with Poland, Bulgaria, Hungary, Italy, Spain, England, France,

USA, Mongolia, Vietnam, Afghanistan, Iran, Iraq and other countries of the world [3, 200 – 215].

Professor Nisbet Mehdiyeva shows in her research that during this period, Azerbaijan – European literary relations were on a large scale. The relevant institutes of the Azerbaijan Academy of Sciences and departments of higher education institutions studied and disseminated these relations, and the separate collections were published [3, 215 – 216].

In the 70s and 80s of the XXth century, the "Ganjlik" publishing house began to publish the most valuable pearls from the treasury of world literature – valuable works in 50 volumes in an elegant layout. Although most of these works were known to the Azerbaijan reader, this series was for the first time that they were published as a whole, as a system. The pearls from the treasury of World Literature were published regularly until 1990 [3, 216].

Professor Nisbet Mehdiyeva notes that in the development of cultural relations, along with the translated literature, book publishing and book promotion, the mutual exchanges in the field of holding book months and book fairs were of great importance.

In 1975, the republic participated in the International Book Exhibition – Fair under the motto "Azerbaijan at the International Book Fair". The International Book Exhibition – Fair held in 1977 was attended by the various foreign publishing houses, book trade companies, enterprises and organizations specializing in the publishing equipment and printing, etc. [3, 218].

In the 80s of the XXth century, the German Foreign Trade Association "Buxexport" held the wholesale book fair in Baku [3, 219].

In the 70s of the XXth century, Azerbaijan Culture Days were held in Bulgaria, Czechoslovakia, Hungary, Poland and Denmark, and Culture Days of these countries were held in Azerbaijan [3, 227].

In 1986, at the VIII Congress of Azerbaijan Writers, the issues such as the renewal of the methods of activity of the creative unions and organizations, and cultural centers, the enrichment of the content of their activity, the meeting of the requirements of the time of all works written, translated and performed in the languages of other peoples, the organization, publication, distribution and promotion of translation work were of a major nature and were examined in detail in the researcher`s works and the attitude to the issue was expressed from the prism of the socio – political analysis of the time [3, 229].

The cooperation in the field of art

The inexhaustible wealth of every nation, along with its language and history, is also its music. Taking care of Azerbaijan music that has been passed down through the centuries, developing, modernizing, promoting and distributing it are the most important tasks facing the Union of Composers of Azerbaijan. For the wide dissemination and promotion of the musical works, art festivals, song and dance festivals, harvest festivals, the release of albums and discs, performances by artists, festivals and other forms and methods were used. According to the researcher, the activity of Azerbaijan composers and musicologists in the field of song promotion were aimed at a wide audience of viewers and listeners [4, 66]. In this regard, an example can be given of the "Arts Festival" held at the Republic Stadium in 1961. More than 60 thousand spectators attended this event [17].

Along with the educational, cultural and scientific centers, the creative unions also actively participate in the formation of the artistic and aesthetic taste of the population, the constant enrichment of its spiritual and moral values, the instilling of a sense of beauty in people so that they can mature as harmoniously developed personalities, and the understanding and appreciation of the unique beauty of works of art, historical and architectural monuments. The researcher notes that in the 1960s, the transcribed works of Azerbaijan composers were widely promoted and sold. In 1965, a store opened in Baku selling new musical works, where music lovers could purchase scores of composers` works [6; 7]. In the field of music promotion in the country, the possibilities of radio and television programs were used. One of the events that the creative unions participated in and organized in the field of promotion of works of art was festivals. In this regard, the researcher noted the music festivals, film festivals, theater and drama festivals, amateur creativity festivals, etc. events. In 1974, the Republican Song Festival was held [20]. The 1976 art festival featured the works by composers from Western Europe, Azerbaijan and other republics [4, 73]. The Azerbaijan composers and musicologists actively participated in the VII International Music Congress in 1971, the III International Music Tribune of Asian and African Countries in 1973, and the International Music Symposium dedicated to the art of mugham in 1978, and performed the significant activity in the field of promotion of music [3, 236].

The film festivals were very important due to their scope and influence. Professor Nisbet Mehdiyeva extensively studied this sphere in her scientific work. In 1960, the scientific and technical film festival called "Science and Technology Achievements in Production" was held in Azerbaijan. During the festival, stands, exhibitions, photo showcases were organized in cinemas, 896 lectures were given, 1632 sessions were shown, and documentary films dedicated to the achievements of science and technology were demonstrated [15]. In 1986, 150 representatives from 70 film studios participated in the VII Festival of Television Youth Programs and Films in Baku [4, 75].

The researcher considers that the certain work has been done in the field of promotion of theatrical art. The cultural relations in the activity of the Azerbaijan theater developed systematically. In the 60 – 80s of the XXth century, the factors such as the lack of proper regulation of the activity of actors, directors, playwrights, the development of cinema, the massification of television programs and other factors caused a certain stagnation in the development of theater.

The cultural relations of the Azerbaijan theater were carried out through the cultural events – meetings, creative relations, tours, months, decades, days, festivals, etc. The organizational measures, live contacts and various auxiliary means were used to implement such events. The various theaters, artists, writers, writer – translators, playwrights, etc. participated in the dramaturgy and theater arts festival held in Azerbaijan in 1979 [1]. At the same time, the researcher notes that the

theater days, decades and festivals of other republics were held in Azerbaijan. İn 1972, the theater days of various republics were held in Baku under the organization of the Republican Theater Society [3, 261].

The creative meetings, exchanges and tours of the Azerbaijan Theater Society and the republic`s theaters were very colorful [3, 263]. İn 1980, the "Creative Youth Theater Week" held in Baku featured the performances based on the works by the various playwrights, as well as discussions and debates [3, 262].

The performance of works by authors from the different countries on the Azerbaijan stage, including the staging of various works by republican playwrights on the theater stages of these nations, is clear evidence of the strengthening of cultural ties between the peoples and the promotion of theater. The Azerbaijan theater groups actively participated in the Bulgarian and Hungarian drama festivals in 1968. The artists participating in the Czechoslovak Culture Decade held in Baku in 1965 performed "Tosca" and "The Legend of Love" by the Azerbaijan State Opera and Ballet Theater. These performances can be considered the main means of the cultural relations between the countries [3, 266]. In 1979, the republican artists and artistic collectives took an important part in the promotion of art in the Netherlands, the Federal Republic of Germany, Italy and Switzerland [3, 268].

The republican festivals of artistic amateurism and youth also played the certain role in the promotion of works of art. The festival of artistic amateurism held in 1970 is noteworthy in this regard [4, 78]. In 1986, the reviews, competitions and exhibitions were held at the II Republican Festival of Folk Art. Here, for the first time, the reviews of performances of drama collectives were held at the folk art festival. The professional directors, actors and theater critics watched the performances of more than 100 collectives – 48 folk theaters, 35 drama circles and 20 propaganda brigades [4, 79]. Professor Nisbet Mehdiyeva rightly points out that the theater propaganda is a complex creative field. The creative organizations, theater groups, playwrights and theater critics take an important part here.

The works of art are mainly distributed and promoted through the exhibitions and reviews. The Union of Artists of Azerbaijan paid the special attention to the promotion of individual exhibitions – creative and report exhibitions. The art historians also closely participated in the promotion of works of fine art. On the one hand, the works of artists were promoted among the population through the exhibitions, and on the other hand, the presentation of art criticism works dedicated to their description and analysis to art lovers ensured the promotion of these works.

İn 1960, the Union of Artists of Azerbaijan held 14 art days and 4 exhibition in the cities during the art week, which were viewed by 90 thousand spectators [12]. İn 1961, more than 200 works of fine art, graphics and sculpture by 120 authors were exhibited at the republican art exhibition [11]. İn 1962, 272.780 spectators viewed the exhibited works of art 97 exhibitions opened in the republic. These exhibitions were selected for their diversity [4, 57]. Between 1966 and 1970, nearly 200 traveling exhibitions were organized in the republic [4, 59].

Professor Nisbet Mehdiyeva notes in her research that the exhibition creativity is the field that requires visuality, dynamism, modernity, relevance and meets the demands of the time [4, 59]. The exhibitions were considered one of the most active forms of aesthetic education of people. Along with the exhibitions of paintings organized by the Union of Artists, viewing of sculptures, drawing, designing and distributing propaganda posters could be considered the important means of promoting works of art. The Union of Artists paid the special attention to the development and promotion of the propaganda poster workshop, constantly improving its work [4, 63]. The diversity, versatility, plot variety, and unique and effective means used in the propaganda poster exhibitions organized in the republic are particularly noteworthy.

The international relations of the Union of Artists of Azerbaijan were manifested in the forms of exhibition and thematic exchanges, establishment of personal contacts, participation of representatives of the Union of Artists of different republics in the Union`s events, etc. In the 70s of the 20th century, the works of Azerbaijan artists were repeatedly exhibited in different republics, and the exhibitions of art samples of other nations were extensively exhibited in the republic [3, 246].

The Azerbaijan artists had the close creative ties with the masters of brushwork from foreign countries. In 1963, the exhibition entitled "Our Contemporary" consisting of the works by Azerbaijan artists was held in Bulgaria, in 1964 the exhibitions were held in Poland and Czechoslovakia, and in 1965 two exhibitions of Azerbaijan artists were held in Prague. In 1965, 400 artists from 42 countries and 10 graphic artists from the formed Soviet Union participated in the VI International Graphic Exhibition in Lyublyana. At the Lyublyana exhibition, the artist A.Rzaguliyev represented Azerbaijan with his engravings [3, 249]. In 1968 – 1970, the exhibitions were held 4 times in the German Democratic Republic, 2 times in Poland and the exhibitions in Hungary, Bulgaria and Romania. In the 70s of the 20th century, the independent exhibition of Azerbaijan artists was held in Poland, the participation of the country`s artists in the Leipzig Fair in the German Democratic Republic, the exhibition of works by republican artists in Czechoslovakia, the personal exhibitions of 2 of our artists in Poland, and participation in the various events and exhibitions were ensured. The participation of republican artists in such international exhibitions has played the major role in the dissemination, promotion and development of all forms and genres of fine art [3, 249 - 250]. The exhibition "Friendship Palette" prepared with the participation of Czechoslovak artists was displayed in Baku. The Azerbaijan artists went on creative missions, painted new paintings, and were engaged in the promotion of these countries, introducing the audience to those countries and their art. In 1959 – 1960, the Azerbaijan artists were sent on missions to Czechoslovakia, Poland, Romania and Bulgaria [3, 250]. The mutual exhibition exchanges continued in the following years. The research scientist Professor Nisbet Mehdiyeva shows that in 1971 – 1975, the exhibitions of works of art from Czechoslovakia,

the German Democratic Republic, Poland, Romania, etc. were held in Baku [3, 251].

Conclusion

The culture, including its components, literature and art, play the important role in the spiritual development of society. The promotion of all spheres of culture is extremely important and can be considered the most powerfull means of influence in the formation of personality as an individual, an independent person. The mutual influence and enrichment in the field of cultural relations is one of the important issues and is always highlighted by its relevance. The mutual national enrichment and cultural cooperation play an important role in establiching and strengthening international relations. The cultural heritage of peoples and their progress in this field are also manifested through the cultural relations. The development and research of the field of propaganda, which is one of the main means of the cultural relations, occupies a key place in this work.

In this regard, the valuable books and monograph of the talented researcher, well – known and prominent scientist, great educator, beautiful person and mother, powerful personality, Doctor of Historical Sciences, Professor Nisbet Mehdiyeva, dedicated to the activity of the Azerbaijan Creative Unions in the field of propaganda, their cultural relations and the development of culture, are extremely valuable research works and are the very valuable source and the huge fundemental work in the study of the activity of the Creative Unions in the 60 – 80s of the 20th century. These works by Professor Nisbet Mehdiyeva, who is always young and always alive, are extremely valuable research works, just like her.

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PHILOLOGICAL SCIENCES

КАЧЕСТВЕННЫЕ ПРИЛАГАТЕЛЬНЫЕ В ОТКАЗНЫХ КНИГАХ XVII ВЕКА

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QUALITATIVE ADJECTIVES IN THE BOOKS OF RENUNCIATIONS OF THE 17TH CENTURY

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АННОТАЦИЯ

Статья посвящена анализу качественных прилагательных в отказных книгах XVII века. В результате исследования памятников деловой письменности было выявлено **44** формы прилагательных. Каждое написание, в котором наблюдаются какие-либо изменения, осуществленные в процессе развития языка, сопровождается соответствующим объяснением, а также статистическими данными.

ABSTRACT

The article analyzes the use of qualitative adjectives in books of renunciations of the 17th century. The study of business writing monuments has led to the identification of **44** adjective forms. Each instance showing any linguistic change in the process of language development is accompanied by an appropriate explanation and statistical data. The study revealed that qualitative adjectives demonstrate notable variation in their forms and usage compared to other lexical and grammatical categories.

Ключевые слова: история русского языка, древнерусские прилагательные, качественные прилагательные, склонение прилагательных, изменение падежных форм, памятники деловой письменности XVII века, отказные книги.

Keywords: history of the Russian language, Old Russian adjectives, qualitative adjectives, declension of adjectives, changes in case forms, business writing monuments of the 17th century, books of renunciations.

Настоящая статья посвящена анализу качественных прилагательных, их падежных форм. Для исследования морфологических процессов были отобраны памятники деловой письменности XVII века. Актуальность темы объясняется тем, что впервые исследуются качественные прилагательные в отказных книгах № 2-5 Владимирского края [1].

Объектом исследования явились прилагательные в памятниках деловой письменности XVII века.

Целью работы является анализ качественных прилагательных, нашедших отражение в отказных книгах. Для достижения цели необходимо было решить следующие **задачи**:

1) выявить качественные прилагательные в памятниках письменности XVII века;

2) выяснить, наблюдаются ли исторические изменения падежных форм прилагательных;

3) определить частотность употребления прилагательных.

При анализе использованы такие **методы** исследования, как:

1) сравнительно-исторический, т.к. восстанавливается исконная древнерусская форма прилагательного;

2) описательный, ибо дается описание исследуемого материала;

3) статистический, т.к. в статье приводится частотность употребления прилагательных в анализируемых памятниках деловой письменности.

Материалом настоящего исследования явились отказные книги Владимирского края XVII века (№ 2-5), которые в данном лингвистическом аспекте не исследовались.

Выявленные формы подаются следующим образом:

1. Приводится падежная форма, затем указывается номер отказной книги (далее ОК) и страница, на которой было отмечено прилагательное.

2. Если слово повторяется, то в скобках указывается частотность его употребления.

3. Если отмечен фонетический или графический вариант падежной формы прилагательного, то такой пример приводится рядом, отделяясь знаком /.

Болшои - ОК2, с. 14 (2). Это форма И.п. ед.ч. м.р. Местоименное прилагательное имеет новую форму окончания, образованную после падения редуцированных гласных. До утраты Ъ, Ь оно выступало в виде **-ии**: ***большии***. Полная форма прилагательного возникла от краткой путем присоединения указательного местоимения м.р. **и**: ***большь + и → большии***. В И.п. это прилагательное имело редуцированный [**и**]: ***большии***, который в эпоху падения кратких гласных закономерно дал **е**: ***большей***. Итак, после XII в. у местоименных прилагательных появились формы типа *нов**ой***, *син**ей***. «*В настоящее время они сохранились в северновеликорусских говорах, которые не знают редукции гласных в безударных слогах. Однако в акающих говорах гласные в безударном окончании подверглись редукции: новъй, синьй. Позже они были вытеснены написаниями старославянского происхождения **-ый**, **-ий**, которые были близки по звучанию к редуцированным гласным: добрый → добрый, синьй → синий. В позиции под ударением сохранилось **-ой**: золото́й, большо́й, молодо́й».* [2, с. 380] *«Окончание* [**ей**] *под ударением вообще не выступает, а в безударном положении произносится с редуцированным* [**ь**]*, а на письме отражается через **и**: синий, верхний».* [3, с. 73] Формы на **-ой**, **-ей** широко употреблялись в орфографии памятников XVII века. Необходимо отметить то, что изменение в окончании гласного **-е** на **-о** обусловлено отвердением исконно мягкого согласного **ш**, которое произошло к XIV веку.

Болшог / болшово - ОК2, с. 14 (2); ОК4, с. 16; ОК5, с. 16. Форма Р.п. ед.ч. м.р. данного прилагательного имеет **2** варианта написания.

Первый пример отражает отвердение шипящего **ш**, т.к. после него в окончании пишется уже **-о-** вместо исконного **-е-**: ***большего → большого***. В то же время мы наблюдаем усечение конечного гласного: ***большог***.

Второй пример также характеризуется наличием **-о-** в окончании. Однако здесь отмечено новое фонетическое произношение, которое зафиксировалось в орфографии памятника: ***-ово*** вместо ***-ого***. Подобное изменение возникло под влиянием формы Р.п. ед.ч. м.р. указательного местоимения – ***того***, «*которая имела в своем составе взрывной [г]. ...в современном литературном языке вместо [г] произносится [в]. Это изменение началось с ослабления взрывного заднеязычного и превращения его во фрикативный звук [ɣ]: [таɣо́]. Дальнейшее ослабление привело к его утрате: [таɣо́ → тоо]. Данная форма известна современным северновеликорусским диалектам. Ввиду того, что русскому языку не свойственно стечение гласных, между двумя гласными развился новый согласный – губной [в]. Форма **тово́** появляется в памятниках письменности с XV в.*» [2, с. 358] Далее [**в**] появляется не только в других местоимениях, имеющих исконно взрывной [**г**], но и в прилагательных. Что нашло свое отражение в примере: *болш**ово***.

Болшему/ болшому - ОК2, с. 13; ОК2, с. 14 (2). Местоименное прилагательное отмечено в форме Д.п. ед.ч. м.р. В исследуемых документах отражено исконное окончание, которое было до отвердения **ш**, а также овое окончание, которое возникло после отвердения конечного губного согласного: ***большемоу → большому***. Оно употребляется и в современном русском языке. На протяжении развития языка в данном окончании произошло графическое изменение буквы **ук**, которая перестала быть лигатурой, что связано с ускорением письма.

Большим - ОК2, с. 13. Местоименное прилагательное отмечено в форме Т.п. ед.ч. м.р. Это мягкий вариант склонения. Форма прилагательного, которая отмечена в памятнике, совпадает с современной: др.-русск. ***большимь*** > совр. русск. ***большим***. Она возникла после падения редуцированных гласных и отвердения конечного **м**.

Болшом - ОК2, с. 14; ОК5, с. 17. Прилагательное отмечено в памятнике в форме П.п. ед.ч. м.р. Оно употреблено в предложении*:* «*... на | том дворе **болшом** дворик людцкои...»*. ОК2, с. 14. Др.-русск. ***болшомь*** → совр. русск. ***большом***. В памятниках деловой письменности мягкость согласных часто не обозначалась, что подтверждается данным и следующими примерами.

Болшая - ОК2, с. 14. Это форма И.п. ед.ч. ж.р. Прилагательное употреблено в предложении: *«... изба **болшая** да поваръня...*»

Болшие / ***болшиѣ*** - ОК2, с. 14; ОК4, с. 16. Местоименное прилагательное отмечено в памятнике XVII века в форме И.п. мн.ч. Данная форма имеет два варианта написания. Первый вариант совпадает с современной формой этого прилагательного. Гласный **ѣ** в древности употреблялся во всех славянских языках. В говоре Москвы, который лег в основу русского литературного языка, на месте **ѣ** стал произноситься **[е]**, что привело к совпадению его с **[е]** исконным. В смоленских грамотах смешение **ѣ** и **е** отмечается с XIII века. Первый вариант прилагательного употреблён в предложении*: «... да ворота **болшие** крыты тесом...».* ОК2, с. 14. Второй вариант - в предложении*: «...**болшиѣ** дороги по воловую межю...»* ОК4, с. 16.

Меньшомоу - ОК2, с. 13, с. 14 (2). Местоименное прилагательное отмечено в форме Д.п. ед.ч. м.р. В исследуемых документах отражено новое окончание, которое возникло после отвердения **ш**.

Меньшим - ОК2, с.13. Прилагательное отмечено в памятнике в форме Т.п. ед.ч. м.р. По своей внешней структуре это прилагательное полностью соответствует современной форме. Подобное окончание возникло после отвердения конечного **м**, что произошло после падения редуцированных гласных.

Великаго / ***великаг*** / ***великого / великог*** - ОК2, с. 13; ОК3, с. 14 (2), с. 15; ОК4, с. 15;ОК5, с. 16. Местоименное прилагательное употреблено в памятнике в форме Р.п. ед.ч. м.р. Это твёрдый вариант склонения.

Первый пример отмечен в старославянской форме. Как отмечалось выше, полные формы прилагательных образовывались от кратких путем присоединения указательного местоимения **ъ**, при этом склонялись обе части. Ср.: Р.п. ед.ч. м.р.

*добр**а+ієго***. «*Постепенно в старославянском языке произошли изменения первоначальных форм прилагательных: Р.п. ед.ч. добр**а+ієго** → добр**аієго** → выпадение йота - добр**аэго**→ уподобление - добр**аго**→ стяжение - добр**аго***». [4, с. 187] Поэтому наличие окончания -**аго** в форме Р.п. выявленного прилагательного указывает на его старославянское происхождение: *велик**аго**. «...цреве і **великаго** князя Михаила...»* ОК5, с. 16. Далее мы наблюдаем усечение конечного гласного, что было свойственно исследуемой деловой письменности: *«...по гсдрве црве | і **великаг** князя Михаила..»* ОК3, с. 14 .В древнерусском языке полные формы прилагательных попали под влияние указательного местоимения **ть**, поэтому в Р.п. ед.ч. м.р. появилось окончание -***ого*** как ***того***: *велик**аго** → велик**ого**. «...по гсдрву црву і**великого** князя Михаила...»* ОК2, с. 13.

Д[о]брои - ОК5, с. 16. Это форма И.п. ед.ч. м.р. Местоименное прилагательное имеет новую форму окончания, образованную после падения редуцированных гласных: ***добры+ и → добрыи → доброи***. Позже это окончание было вытеснено старославянским **-ый**.

Добрые - ОК5, с. 16 (5), с. 17 (4). Прилагательное отмечено в форме И.п. мн.ч. Имеет твёрдый вариант склонения. Форма полностью совпадает с современной. «*...по крестьянскои сказке **добрые** земли | полосмины ...»* ОК5, с. 16.

Хорошое - ОК5, с. 16. Пример отмечен в И.п. ед.ч. ср.р. До XIV века шипящие были непарными мягкими. Потом они отвердели, и в деловой письменности отражается новое окончание **-ое** вместо – **ее**: *«...**хорошое** по свещеничес[кой] | смете...».*

Старою - ОК4, с. 16. Местоименное прилагательное отмечено в форме В.п. ед.ч. ж.р. Прилагательное относится к твёрдому варианту склонения: «*...на **старою** плотину*». На протяжении развития языка произошло графическое изменение буквы **ук**.

Пустое - ОК3, с. 14. Прилагательное зафиксировано в памятнике в форме И.п. ед.ч. ср.р. Это твёрдый вариант склонения. Полностью совпадает с современной формой. Употреблён в предложении: «*...переписал живуще*ѣ *и **пустое** | и сколько деревен...*»

Пустово - ОК3, с. 15 (4). Это форма Р.п. ед.ч. м.р. Прилагательное относится к твёрдому варианту склонения. Здесь отмечено новое произношение, которое зафиксировалось в орфографии памятника: ***-ово*** вместо ***-ого***.

Малая - ОК2, с. 14. Прилагательное отмечено в форме И.п. ед.ч. ж.р. Данная форма совпадает с современной: «*да инбаръ болшои да конушня **малая**»*.

Новы - ОК2, с. 14. Это именная форма прилагательного, которая отмечена в И.п. мн.ч. Данное прилагательное имеет твёрдый вариант склонения. Употреблено в следующем предложении: «*... **новы** крестияня Редрикова...*»

Таким образом, в результате проведенного исследования было выявлено **44** формы качественных прилагательных. Многие из них уже приобрели то окончание, которое дошло до наших дней.

В отказных книгах XVII века, которые представляют деловой язык, отразились колебания в написаниях прилагательных, так отмечены многочисленные фонетические и графические варианты окончаний. Безусловно, это связано с уровнем грамотности писцов.

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NATIONAL IDENTITY, MILITARY-PATRIOTIC VALUES IN MODERN AZERBAIJANI LITERATURE AND THEIR ROLE IN CADET TRAINING

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ABSTRACT

Modern Azerbaijani literature plays a pivotal role in shaping national identity, reinforcing military-patriotic values, and supporting the moral and psychological development of future military personnel. Beyond its artistic and aesthetic dimensions, literature serves as a cultural platform where national consciousness, ideological orientation, moral resilience, and devotion to the homeland are cultivated. This paper explores the representation of homeland, war, and victory in contemporary Azerbaijani literature, emphasizing its significance in cadet training. Works by authors such as Xəlil Rza Ulutürk, Bəxtiyar Vahabzadə, Aqil Abbas, and others are analyzed to demonstrate how literature fosters ideological stability, psychological endurance, leadership, and national responsibility among cadets. Integrating literature into military education not only enhances knowledge but also strengthens moral and patriotic consciousness, thereby contributing to the development of ideologically and emotionally prepared military personnel.

Keywords: Modern Azerbaijani literature; national identity; military-patriotic values; cadet training; homeland; war; victory.

Introduction

In the modern era, state security, national power and military strength are not limited only to military technology, defense capacity or tactical preparation. One of the most important conditions for building a strong army is the training of personnel who are ideologically committed to national values, morally resilient, psychologically stable and deeply patriotic. At this point, Azerbaijani literature plays an irreplaceable role. Literature is not merely an artistic field; it is a cultural platform where national consciousness, ideological stance, moral firmness and devotion to the homeland are formed.

Throughout history, Azerbaijani literature has fulfilled the mission of preserving national identity, strengthening love for the homeland and keeping the national spirit alive. From classical poetry to modern prose, the rich literary heritage plays a crucial role in shaping the ideological worldview of youth, especially military cadets.

Nature of National Identity and Military-Ideological Values

National identity represents unity of historical memory, cultural heritage, language, religion, traditions, territorial consciousness and moral values distinguishing one nation from another. Azerbaijani national identity has been strengthened through the struggle for independence, defense of homeland and preservation of national unity. Military-patriotic ideology, as an integral part of national identity, promotes fundamental values such as:

- loyalty to the Motherland,
- devotion to the state,
- sanctity of territory,
- respect for martyrdom,
- heroism and courage,
- national unity and responsibility.

Formation of National Spirit and Military Ideology in Azerbaijani Literature

Azerbaijani literature has always acted as the carrier of national ideas. During the 19th–20th centuries, alongside the rise of national liberation movements, literature became an ideological platform awakening national consciousness.

The period of the Karabakh War marked a new stage. Works created during this period reflected:

- the pain of lost lands,
- tragedy of displacement,
- sanctity of martyrdom,
- determination to struggle,
- belief in victory.

Thus, literature transformed into a powerful ideological instrument contributing to the preservation of national memory and transferring moral responsibility to future generations.

Homeland, War and Victory Concepts in Modern Azerbaijani Literature

In modern Azerbaijani literature, the Homeland is not only a geographical territory but a spiritual value, symbol of historical memory and moral support. Especially in Karabakh-themed works, the homeland appears as both love, pain and pride.

War is reflected not merely as combat scenes but as a deep psychological and moral trial of human destiny and national existence. Xəlil Rza Ulutürk's *"Şəhidlər"* (Martyrs) is not only a poetic text but a powerful call to struggle and symbol of national determination. Bəxtiyar Vahabzade's poem *"Gülüstan"* expresses the tragedy of divided homeland and strengthens the aspiration for national unity.

Later, works such as Aqil Abbas' novel *"Dolu"* (2009) and Elçin Hüseynbəyli's war prose realistically portray the psychological impact of war, internal struggles of individuals, fear and courage existing simultaneously (Abbas, 2009; Hüseynbəyli, 2000).

Following the 44-day Patriotic War, a new stage of "Victory Literature" emerged. This literature celebrates:

- heroism of Azerbaijani soldiers,

- philosophical meaning of martyrdom,
- unity of state-people-army,
- restoration of historical justice.

Alongside glorifying victory, modern literature also reflects psychological and social realities of war veterans, demonstrating that war is a deep human and social phenomenon.

Modern literature also reflects psychological and social realities of war veterans, demonstrating that war is a deep human and social phenomenon (Əliyev, 2022).

Thus, Homeland, War and Victory concepts in modern Azerbaijani literature serve not only as artistic ideas but as an ideological-moral system reinforcing national identity and patriotic spirit.

Scientific-Pedagogical Perspective on the Role of Literature in Cadet Training

Cadet training cannot be limited to physical or tactical preparation. It must ensure:

- formation of national spirit,
- strengthening moral resilience,
- psychological endurance,
- development of leadership qualities,
- responsibility and devotion.

Integrating Azerbaijani literature into military education plays a crucial role, for literature forms not only knowledge but also feelings, emotional connection and internal motivation. Cadets identify themselves with heroic characters, comprehend the sacredness of martyrdom and internalize the meaning of homeland.

Mechanisms of Literary Influence on Cadet Personality

Literature influences cadet upbringing in several dimensions:

1. Ideological impact – strengthens national consciousness and ideological commitment.

2. Psychological impact – prepares cadets for stress, fear management and resilience.

3. Moral-educational impact – deepens understanding of sacrifice and responsibility.

4. Leadership and character building – heroic characters serve as behavioural models.

5. Preservation of national memory – keeps historical consciousness alive.

Azerbaijani Experience in Integrating Literature into Military Education

In modern Azerbaijani military education, patriotic education is a strategic direction. Literature contributes through:

- inclusion of patriotic literature in curricula,
- literary-patriotic events,
- commemorative events dedicated to martyrs,
- essay competitions among cadets,
- systematic promotion of national values through literature.

This ensures not only knowledge development but moral-ideological maturity.

Conclusion

Modern Azerbaijani literature has strategic importance in strengthening national identity, patriotic spirit and military ideology. It not only reflects historical events but preserves national spirit, consolidates ideological stance and supports moral-psychological preparation of future military personnel.

Systematic application of literature in cadet training:

- ensures ideological stability,
- strengthens national identity consciousness,
- enhances psychological endurance,
- develops leadership and responsibility,
- reinforces loyalty to the Motherland.

Therefore, literature should be regarded not merely as a humanitarian discipline but as one of the key ideological foundations of national security, moral resilience and military strength.

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PHYSICS AND MATHEMATICS

MBK-T½-SPACES

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ABSTRACT

Firstly, we give some characterizations of the concepts both mbk-closed sets and mbk-g-closed sets. Then, we obtain that mbk-$T_{½}$-space is stronger than mbk-T_0-space and weaker than mbk-T_1-space. To give a decomposition of mbk-T_1-space, we define the concept of mbk-symmetric as a new space and give a characterization of this space. Finally, we also obtain that each of the mbk-T_i-space such that i={0,1/2,1} concepts coincides with the other in mbk-symmetric spaces.

Keywords: mbk-open sets, mbk-closed sets, mbk-g-closed sets, mbk-T_i-spaces (i={0,1/2,1}), mbk-symmetric spaces.

1. INTRODUCTION AND PRELIMINARIES

Topology is a new branch of geometry. Each of elements of a topology is called open set. On the other hand; the concept of δ-open sets was introduced by Velicko [10] as a strong type of the concept of open sets. Then, some of modifications of this type of set have been densely studied from authors such as [8], [1], [2], [3], [4] and [7]. In fact, the purpose of this study is to introduce mbk-open sets. Topology is a special subcollection of P(Z) such that P(Z) is power set of Z. We use the symbol (Z,τ) for a topological space. For a $T\subseteq Z$, the closure of T and the interior of T are denoted by cl(T) and int(T), respectively in a space (Z,τ). It is known that a subset T is said to be regular open (resp. regular closed) [9] if T=int(cl(T)) (resp. T=cl(int(T))). The δ-interior of T([10]) is consist of $M\subseteq T$ such that for every M is regular open and is denoted by δint(T) and defined. A subset X is called δ-open if T = δint(T). The collection of all δ-open sets is a topology on Z and denoted by τ^{δ} such that $\tau^{\delta}\subseteq\tau$. The complement of a δ-open is called δ-closed. Similarly, the δ-closure of T([9]) is consist of $z\in Z$ such that $(K\cap P)\neq\emptyset$ for every K is regular closed neighborhood of $z\in Z$ and is denoted by δcl(T). A subset T is said to be generalized closed set [6]) if $cl(T)\subseteq U$, whenever $T\subseteq U$ and U is open. Let (Z,τ) be a topological space and $X\subseteq Z$. Then X is is said to be a mbk-open [5] if $X\subseteq[cl(\delta int(X))\cup int(cl(int(X)))]$.

2. MBK-G-CLOSED SETS AND MBK-$T_{½}$-SPACES

We must state that this section is consisted of two parts. In the first part, we introduce the notions of mbk-closed sets and mbk-g-closed set in topological spaces and obtain some characterizations and properties. In the last part, we give that some fundamental and important properties of mbk-$T_{½}$-space.

Definition 2.1. Let X be a subset of a topological space (Z,τ). X is said to be an mbk-closed if it's complement is a mbk-open.

The intersection of all mbk-closed sets containing X is said to be mbk-closure of X and it is denoted by mbk-cl(X). Of course, the next property is true: "X is mbk-closed set in (Z,τ) if and only if X= mbk-cl(X)."

Theorem 2.2. For the mbk-closure of subsets X,Y in a topological space (Z,τ), the next properties hold:

(1) If $X\subseteq Y$, then $mbk\text{-}cl(X)\subseteq mbk\text{-}cl(Y)$;

(2) mbk-cl(X) is an mbk-closed, that is mbk-cl(X)=mbk-cl(mbk-cl(X));

(3) $z\in$mbk-cl(X) if and only if $X\cap T\neq\emptyset$ for every mbk-open set T of Z containing z.

Proof. It is obvious.

Since g-closed set is a generalization of closed sets. So, we define a type of generalized closed set using mbk-closed.

Definiton 2.3. A subset of X of a topological space (Z,τ) is said to be mbk-g-closed if $mbk\text{-}cl(X)\subseteq T$ whenever $X\subseteq T$ and T is a mbk-open set in Z.

Proposition 2.4. In a topological space (Z,τ), $X\subseteq Z$ is mbk-g-closed if and only if $mbk\text{-}cl(\{z\})\cap T\neq\emptyset$ holds for every $z\in$mbk-cl(X).

Proof. Sufficiency. Let T be a mbk-open set and $X\subseteq T$. According to hypothesis, there exists a $y\in$mbk-cl({z}) and $y\in X\subseteq T$. It follows from Theorem 2.2(3) that $T\cap\{z\}\neq\emptyset$. Therefore $z\in T$ and this implies that $mbk\text{-}cl(X)\subseteq T$. So, X is a mbk-g-closed in (Z,τ).

Necessity. Let X be a mbk-g-closed subset of Z and $z\in$mbk-cl(X) such that $mbk\text{-}cl(\{z\})\cap T\neq\emptyset$. According to Theorem 2.2(2) since mbk-cl({z}) is a mbk-closed, we have (Z-(mbk-cl({z}))) is a mbk-open set from Definition 1.1. Since $X\subseteq$(Z-(mbk-cl({z}))) and X is a mbk-g-closed, we have $mbk\text{-}cl(X)\subseteq$(Z-(mbk-cl({z}))) and hence $z\notin$mbk-cl(X). This is contradiction and hence $mbk\text{-}cl(\{z\})\cap X\neq\emptyset$.

Theorem 2.5. Let (Z,τ) be a topological space and $X\subseteq Z$. If $mbk\text{-}cl(\{z\})\cap X\neq\emptyset$ holds for every $z\in$mbk-cl(X), then (mbk-cl(X)-X) doesn't contain a non-empty mbk-closed set.

Proof. Let K is a non-empty mbk-closed set and $K\subseteq$(mbk-cl(X)-X). If $z\in K$, then we have $z\in$mbk-cl(X). So, $\emptyset\neq(mbk\text{-}cl(\{z\})\cap X)\subseteq(mbk\text{-}cl(K)\cap X)=K\cap X$ and so $K\cap X\neq\emptyset$. This is a contradiction.

Corollary 2.6. For a subset X of a topological space (Z,τ), the next equivalent is hold: "X is an mbk-g-closed set if and only if X=(K-F), where K is an mbk-closed and F contains no non-empty mbk-closed subset."

Proof. Necessity. The proof is obtained from Proposition 2.4 and Theorem 2.5 by taking K=mbk-cl(X) and F=(mbk-cl(X)-X).

Sufficiency. If X=(K-F) and X⊆T with T is a mbk-open, then (K∩(Z-T)) is a mbk-closed subset of F and hence it is empty. Therefore, mbk-cl(X)⊆K⊆T.

Theorem 2.7. Let (Z,τ) be a topological space. If X⊆Z is a mbk-g-closed set and X⊆Y⊆mbk-cl(X), then Y⊆Z is a mbk-g-closed.

Proof. Let X be an mbk-g-closed set such that X⊆Y⊆mbk-cl(X). Let T be a mbk-open set of Z such that Y⊆T. Since X is a mbk-g-closed, we have mbk-cl(X)⊆T. Using Theorem 2.2(1) and Theorem 2.2(2), mbk-cl(X)⊆mbk-cl(Y)⊆mbk-cl(mbk-cl(X))=mbk-cl(X)⊆T and hence mbk-cl(Y)⊆T. So, T⊆Z is a mbk-open and Y⊆Z is a mbk-g-closed.

Theorem 2.8. Let (Z,τ) be a topological space. Then for each z∈Z, either {z}⊆Z is a mbk-closed or (Z-{z})⊆Z is a mbk-g-closed.

Proof. Assume that {z} isn't mbk-closed, then (Z-{z}) isn't mbk-open from Definition 2.1. Let T be any mbk-open set such that (Z-{z})⊆T and hence T=Z. Therefore mbk-cl(Z-{z})⊆T and hence (Z-{z}) is a mbk-g-closed.

Definition 2.9. A topological space (Z,τ) is said to be mbk-$T_{½}$-space if every mbk-g-closed set is mbk-closed.

Theorem 2.10. A topological space (Z,τ) is a mbk-$T_{½}$-space if and only if {z}⊆Z is a mbk-closed or mbk-open.

Proof. Necessity. Assume that {z}⊆Z isn't mbk-closed. From Theorem 2.8, (Z-{z}) is a mbk-g-closed and using hypothesis we have (Z-{z}) is a mbk-g-closed and hence {z}⊆Z is a mbk-open.

Sufficiency. Let K be a mbk-g-closed subset of Z and z∈mbk-cl(K). Then, {z} is a mbk-closed or mbk-open.

(1) Assume that {z} is a mbk-closed and z∉K. Then, we have z∈(mbk-cl(K)-K). But according to Theorem 2.3, this isn't possible and hence we have z∈K. So mbk-cl(K)=K and hence K is mbk-closed.

(2) Assume that {z} is a mbk-open. By using Theorem 2.2(3), we have {z}∩K≠∅ and hence z∈K. This implies that mbk-cl(K)⊆K and hence K is a mbk-closed.

Eventually, we obtain that (Z,τ) is a mbk-$T_{½}$-space from Definition 2.9.

Definition 2.11. A topological space (Z,τ) is called a mbk-symmetric space if for z and y in Z, z∈mbk-cl({y}) implies that y∈mbk-cl({z}).

Theorem 2.12. (Z,τ) is a mbk-symmetric space if and only if {z}⊆Z is a mbk-g-closed, for each z∈Z.

Proof. Necessity. Let {z}⊆T, T⊆Z is a mbk-open and mbk-cl({z})⊄T. So, [mbk-cl({z})∩(Z-T)]≠∅ is true. There is y∈[mbk-cl({z})∩(Z-T)] and using Definition 2.11, z∈mbk-cl({y}) is obtained. Since y∈(Z-T) and (Z-T)⊆Z is a mbk-closed, mbk-cl({y})⊆(Z-T) from Theorem 2.2(2). So, z∈mbk-cl({y})⊆(Z-T) and z∉T. This is contradiction and hence, {z} is a mbk-g-closed for each z∈Z.

Sufficiency. Let {z} is a mbk-g-closed, for ech z∈Z. Let z∈mbk-cl({y}) and y∉mbk-cl({z}). Then, {y}⊆(Z-mbk-cl({z})) and mbk-cl({y})⊆(Z-mbk-cl({z})). So z∈(Z-mbk-cl({y})). This is a contradiction and we have y∈mbk-cl({z}). This shows that (Z,τ) is a mbk-symmetric.

Definition 2.13. A topological space (Z,τ) is said to be

(1) mbk-T_0-space if for each pair of distinct points z,y in Z there exists a mbk-open set T such that either z∈T and y∉T or y∈T and z∉T.

(2) mbk-T_1-space if for each pair of distinct points z,y in Z there exist two mbk-open sets T and U such that either z∈T and y∉T and y∈U and z∉U.

Lemma 2.14. A topological space (z,τ) is an mbk-T_1-space if and only if the singletons are mbk-closed sets.

Lemma 2.15. Every mbk-T_1-space is a mbk-T_0.

Corollary 2.16. Every mbk-T_1-space is a mbk-symmetric.

Proof. Let (Z,τ) is a mbk-T_1-space. Using Lemma 2.14, every singleton is a mbk-g-closed subset of Z. Hence we obtained that (Z,τ) is a mbk-symmetric space from Theorem 2.12.

Corollary 2.17. A topological space (Z,τ) is a mbk-T_1 if and only if it is a mbk-symmetric and mbk-T_0.

Proof. Necessity. The proof is obtained from Corollary 2.16 and Lemma 2.15.

Sufficiency. Let y≠z and (Z,τ) be a mbk-T_0-space. Assume that z∈T⊆(Z-{y}) for some T⊆Z is a mbk-open. So, z∉mbk-cl({y}) and hence y∉mbk-cl({z}). Then, there exists a mbk-open set U such that y∈U⊆(Z-{z}). This shows that (Z,τ) be a mbk-T_1-space.

Remark 2.18. For any topological space (Z,τ), the next statements are hold:

(1) If (Z,τ) is a mbk-T_1-space, then it is a mbk-$T_{½}$.

(2) If (Z,τ) is a mbk-$T_{½}$ -space, then it is a mbk-T_0.

Proposition 2.19. For a mbk-symmetric space (Z,τ), the next properties are equivalent:

(1) (Z,τ) is a mbk-T_0-space.

(2) (Z,τ) is a mbk-$T_{½}$-space.

(3) (Z,τ) is a mbk-T_1-space.

Proof. (1)⇔(3). The proof is obvious from that Corollary 2.11.

(3)⇒(2) and (2)⇒(1) are obtained directly from Remark 2.13.

3. RESULTS AND DISCUSSION

The notion of generalized closed sets is an important subject on topological spaces. To contribute of this area, we have devoted this article to investigating a new generalization of closed sets which name is mbk-closed. We give a characterization of mbk-$T_{½}$-spaces which is related to an mbk-closed set or mbk-open set. To obtain decomposition of mbk-T_1-spaces, we introduce the concept of mbk-symmetric spaces. We obtain that mbk-$T_{½}$-spaces is between mbk-T_0-spaces and mbk-T_1-spaces. Finally, in mbk-symmetric spaces we also give that the three separation axioms mentioned above coincide with each other. Our future plan will focus on decompositions of mbk-closed sets related to

mbk-g-closed. Then, we will study on continuity using what we can get.

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THREE FUNCTIONS FOR MBK-OPEN SETS

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ABSTRACT

In this study, we introduce a new family of functions called mbk-irresolute functions and give some characterizations of them. By introducing the mbk-continuous functions regarding mbk-open sets, some of its properties and equivalences are obtained. Besides, we present a new the concept of the graph of a function called a mbk-closed graph and investigate some of their basic properties.

Keywords: mbk-open sets, mbk-irresolute functions, mbk-continuous functions, mbk-closed graph functions.

1. INTRODUCTION AND PRELIMINARIES

Let G be a subset of Z and (Z,ω) be a topological space (briefly, space). G⊆Z is said to be open[4] iff G∈ω. Complements of open sets are said to be closed. The interior of G (resp. closure of G) is denoted by int(G) (resp. cl(G)). It is known that a subset G is said to be regular open (resp. regular closed) [5] if G=int(cl(G)) (resp. G=cl(int(G))). The δ-interior of G([6]) is consist of H⊆G such that for every H is regular open and is denoted by δint(G) and defined. A subset G is called δ-open if G=δint(G). The collection of all δ-open sets is a topology on Z and denoted by ω^{δ} such that $\omega^{\delta}\subseteq\omega$. The complement of a δ-open is called δ-closed. Similarly, the δ-closure of G([5]) is consist of z∈ Z such that (J∩G)≠∅ for every J is regular closed neighborhood of z∈Z and is denoted by δcl(G).

Recall some necessary knowledges.

Definition 1.1. ([1]) Let (Z,ω) be a topological space and G⊆Z. Then G is said to be an mbk-open if $G\subseteq clo(\omega_{\gamma}\text{-}int(G))\cup int(\omega_{\gamma}\text{-}clo(G))$.

The family of all mbk-open sets of Z will be denoted by MBKO(Z).

Remark 1.2. ([1]) Although MBKO(Z) is closed under arbitrary union but isn't closed under finite intersection. So, it doesn't form a topology.

Definition 1.3. ([2]) Let (Z,ω) be a topological space and G⊆Z. G is said to be a mbk-closed if (Z-G) is a mbk-open set. mbk-cl(G)=∩{T⊆Z: G⊆T, T is mbk-closed set} is said to be mbk-closure of G.

Lemma 1.4. ([2]) For G⊆Z in (Z,ω), then G is mbk-closed set iff G=mbk-cl(G).

Definition 1.5. (Z,ω) is said to be

(1) mbk-T_0-space[2] if for each $z_1,z_2\in Z$ when $z_1\neq z_2$ there exists a P∈MBKO(Z) so that either $z_1\in P$ and $z_2\notin P$ or $z_2\in P$ and $z_1\notin P$.

(2) mbk-T_1-space[2] if for each $z_1,z_2\in Z$ when $z_1\neq z_2$ there exist P,W∈MBKO(Z) so that $z_1\in P$, $z_2\in W$, $z_2\notin P$ and $z_1\notin W$.

Definition 1.6. ([4]) (Z,ω) is said to be

(1) T_1-space if for each $z_1,z_2\in Z$ when $z_1\neq z_2$ there exist P,U∈ω so that $z_1\in P$, $z_2\in W$, $z_2\notin P$ and $z_1\notin W$.

(2) T_2-space if for each $z_1,z_2\in Z$ when $z_1\neq z_2$ there exist P,W∈ω so that $z_1\in P$, $z_2\in W$ and (P∩W)=∅.

The family of all closed sets of (X,ϖ) will be indicated by ϖ^{ι}. In this paper, we introduce three functions related to mbk-open sets. Besides, we obtain some properties of them.

2. MBK-IRRESOLUTE FUNCTIONS, MBK-CONTINUOUS FUNCTIONS AND MBK-CLOSED GRAPHS

In this section, firstly we introduce three notions which are mbk-irresolute functions, mbk-continuous functions and mbk-closed graph functions. Then, we obtain some fundamental properties.

Definition 2.1. For G be a subset of (Z,ω), mbk-ker(G)=∩{P⊆Z: P∈MBKO(Z), G⊆P}⊆Z is called mbk-kernel of G.

Theorem 2.2. In any topological space (Z,ω), y∈mbk-ker({z}) iff z∈mbk-ker({y}).

Proof. Sufficiency. Let y∉mbk-ker({z}). Then, there exists a P∈MBKO(Z) so that z∈P and y∉P. Therefore, z∉mbk-ker({y}).

Necessity. This proof is obtained similarly the proof of sufficiency.

Definition 2.3. A subset G of (Z,ω) is called an mbk-neighborhood of a point z∈Z if there exists a P∈MBKO(Z) so that z∈P⊆G.

Theorem 2.4. For a subset G of (Z,ω), then mbk-ker(G)={z∈Z: mbk-ker({z})∩G≠∅}.

Proof. Let z∈mbk-ker(G) and assume that mbk-ker({z})∩G=∅. So, z∉(Z-mbk-ker({z})) so that (Z-mbk-ker({z}))∈MBKO(Z) and G⊆(Z-mbk-ker({z})) from Definition 1.1. Since z∈mbk-ker(G), this is unpossible. Hence mbk-ker({z})∩G≠∅ and mbk-ker(G)⊆{z∈Z:mbk-ker({z})∩G≠∅}.

Conversely, let z∈Z and mbk-ker({z})∩G≠∅. Assume that z∉ mbk-ker(G). Then there exists a P∈MBKO(Z) so that G⊆P and z∉P. From hypothesis, let y∈[mbk-ker({z})∩G]. Hence V is a mbk-neighborhood of y so that z∉V. So, this is contradiction and z∈mbk-ker(G). Hence, {z∈Z: mbk-ker({z})∩G≠∅}⊆ mbk-ker(G).

Eventualy, mbk-ker(G)={z∈Z: mbk-ker({z})∩G≠∅} is hold.

Definition 2.5. A subset G of (Z,ω) is called an mbk-D-set if there are two mbk-open sets P and W such that P≠Z and G=(P-W).

Proposition 2.6. Let (Z,ω) be a topological space and z∈Z. If a singleton {z} is an mbk-D-set, then mbk ker({z})≠Z.

Proof. Since {z} is an mbk-D-set of Z, there exist P,W∈MBKO(Z) so that P≠Z and {z}=(P-W). Hence mbk-ker({z})⊆P≠Z and so mbk-ker({z})≠Z.

Definition 2.7. f:(Z,ω)→(X,ϖ) is said to be a mbk-irresolute function if for each z∈Z and each V∈MBKO(X)(f(z)∈V), there is an P∈MBKO(Z)(z∈P) such that f(P)⊆V.

Theorem 2.8. If f:(Z,ω)→(X,ϖ) is an mbk-irresolute surjective function and H⊆X is an mbk-D-set, $f^{-1}(H)$⊆Z is an mbk-D-set.

Proof. Let H⊆X be an mbk-D-set. So, there are S,V∈MBKO(X) so that S≠X and W=(S-V). As f is an mbk-irresolute, $f^{-1}(S)$,$f^{-1}(V)$∈MBKO(Z) by using Definition 2.7. Since S≠Y and f is surjective, $f^{-1}(S)$≠Z. So, $f^{-1}(H)=(f^{-1}(S)-f^{-1}(V))$ and $f^{-1}(H)$⊆Z is an mbk-D-set.

Definition 2.9. A function f:(Z,ω)→(X,ϖ) is called an mbk-continuous function if $f^{-1}(S)$⊆Z is an mbk-open set, for each S⊆X is open.

Theorem 2.10. For a function f:(Z,ω)→(X,ϖ), the next properties are equivalent:

(1) f is an mbk-continuous;

(2) $f^{-1}(R)$⊆Z is an mbk-closed, for each R∈ϖ^t;

(3) f(mbk-cl(G))⊆cl(f(G)), for each G⊆Z;

(4) mbk-cl($f^{-1}(H)$)⊆f^{-1}(cl(H)), for each H⊆X.

Proof. (1)⇒(2) This proof is clear.

(3)⇒(4) Let H⊆X. Then, by using (3) f(mbk-cl($f^{-1}(H)$))⊆cl(f(($f^{-1}(H)$))⊆cl(H). Therefore, mbk-cl($f^{-1}(H)$)⊆f^{-1}(cl(H)).

(4)⇒(3) Let H=f(G), for G⊆Z. Then, from (4) mbk-cl(f^{-1}(f(G)))⊆f^{-1}(cl(f(G))). Eventualy, f(mbk-cl(G))⊆cl(f(G)).

(2)⇒(4) Let H⊆X. As f^{-1}(cl(H))⊆Z is an mbk-closed, $f^{-1}(H)$⊆f^{-1}(cl(H)) by using Lemma 1.4. Therefore, mbk-cl($f^{-1}(H)$)⊆mbk-cl(f^{-1}(cl(H)))=f^{-1}(cl(H)) and mbk-cl($f^{-1}(H)$)⊆f^{-1}(cl(H)).

(4)⇒(2) Let R∈ϖ^t. Using (4), mbk-cl($f^{-1}(R)$)⊆f^{-1}(cl(R))=$f^{-1}(R)$. Then $f^{-1}(R)$⊆Z is a mbk-closed and hence f is a mbk-continuous.

Definition 2.11. (Z,ω) is said to be mbk-T_2-space if for each z_1,z_2∈Z when z_1≠z_2 there exist P,W∈MBKO(Z) so that z_1∈P, z_2∈W and (P∩W)=∅.

Theorem 2.12. If f:(Z,ω)→(X,ϖ) is a mbk-continuous injective function and (X,ϖ) is T_2-space, then (Z,ω) is a mbk-T_2.

Proof. Let z_1,z_2∈Z when z_1≠z_2. According to hypothesis since f is injective f(z_1),f(z_2)∈X so that f(z_1)≠f(z_2). Since (X,ϖ) is T_2-space, using Definition 1.6(2) there exist S,V∈ϖ so that f(z_1)∈S, f(z_2)∈V and S∩V=∅. As f is a mbk-continuous function f^{-1}(S), f^{-1}(V)∈MBKO(Z) so that z_1∈f^{-1}(S) and z_2∈f^{-1}(V). Therefore, f^{-1}(S)∩f^{-1}(V)=f^{-1}(S∩V)=f^{-1}(∅)=∅ and f^{-1}(S∩V)=∅. Hence, (Z,ω) is a mbk-T_2 from Definition 2.11.

Definition 2.13. For a function f:(Z,ω)→(X,ϖ), the graph G(f)={(z,f(z)):z∈Z} is called mbk-closed if for each (z,x)∉G(f), there exist a P∈MBKO(Z) and a V∈ϖ so that z∈P, x∈V and (P×V)∩G(f)=∅.

Lemma 2.14. The function f:(Z,ω)→(X,ϖ) has a mbk-closed graph iff for each z∈Z and x∈X when x≠f(z) there exist a P∈MBKO(Z) and a V∈ϖ so that z∈P, x∈V and f(P)∩V=∅.

Theorem 2.15. If f:(Z,ω)→(X,ϖ) is an injective function with mbk-closed graph, then (Z,ω) is a mbk-T_1.

Proof. Let z_1,z_2∈Z when z_1≠z_2. As f is injective, then f(z_1)≠f(z_2). Since f has a mbk-closed graph there exist a P∈MBKO(Z) and a V∈ϖ such that z_1∈P, f(z_2)∈V and f(P)∩V=∅. So, z_2∉P and hence (Z,ω) is a mbk-T_1 using Definition 1.5(2).

Theorem 2.16. If f:(Z,ω)→(X,ϖ) is an injective mbk-continuous function with mbk-closed graph, then (Z,ω) is a mbk-T_2.

Proof. Let z_1,z_2∈Z when z_1≠z_2. As f is injective, then f(z_1)≠f(z_2) and (z_1,f(z_2)∈[(Z×Y)-G_f)]. Since the graph G_f is a mbk-closed, a P∈MBKO(Z) and a V∈ϖ so that z_1∈P, f(z_2)∈V and f(P)∩V=∅. As f is a mbk-continuous, f^{-1}(V)∈MBKO(Z) so that z_2∈f^{-1}(V) and P∩f^{-1}(V)=∅. Therefore, (Z,ω) is a mbk-T_2 by using Definition 2.11.

Theorem 2.15. If f:(Z,ω)→(X,ϖ) is a surjective function with mbk-closed graph, then (X,ϖ) is a T_1-space.

Proof. Let x_1,x_2∈X when x_1≠x_2. Since f is surjective, there exists z∈Z so that f(z)=x_2 and hence (z,x_1)∉G_f. From Lemma 2.14, there exist a P∈MBKO(Z) and a V∈ϖ so that z∈P, x_1∈V and f(P)∩V=∅. So, f(z)=x_2∉V and (X,ϖ) is a T_1-space from Definition 1.6(1).

3. RESULTS AND DISCUSSION

The notion of continuity is one of the most important subjects on topology. So, it is studied densely several authors. We focus on three functions which names are mbk-irresolute, mbk-continuous and mbk-closed graph for the concept of mbk-open sets. Besides, we introduce the concept of mbk-D-sets and obtain some properties related to it. Our future plan will focus on separation axioms by using mbk-D-sets. For them, we will examine these axioms under the three functions we focus on in this study.

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TWO GRAPH FUNCTIONS OF MBK-OPEN SETS

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ABSTRACT
We introduce the concepts contra δ-b-closed graphs and strongly contra mbk-closed graphs for mbk-open sets and obtain some properties of them.
Keywords: mbk-open sets, mbk-closed graphs, contra mbk-closed graphs, contra mbk-continuous functions.

1. INTRODUCTION

In this study, spaces (X,τ) and (Y,φ) (briefly, X and Y) always state topological spaces without any separation axiom. If $A\subseteq X$, closure and interior of A in X are indicated by cl(A) and int(A) respectively. The notion of regular open sets is important several in branches of mathematics. A subset A is called be regular open[11] (resp. regular closed[11] if A=int(cl(A)) (resp. A=cl(int(A))). Of course, regular closedness is complement of regular openness. The δ-interior of a subset A of X is the union of all regular open sets of X contained A and it is denoted by δ-int(A). A is called δ-open[12] iff A=δ-int(A). δ-open sets in X forms a topology τ_δ so that $\tau_\delta\subseteq\tau$ and the regular open sets of X form a base for τ_δ. The δ-closure of a subset A of X is the intersection of all regular closed sets of X containing A and it is denoted by δ-cl(A). A is called δ-closed[12] iff A=δ-cl(A).

We recall some definitions.

Definition 1.1. A space (X,τ) is called

(1) Urysohn[4] if for each $x_1, x_2\in X$ with $x_1\neq x_2$, there exist open sets U and V so that $x_1\in U$, $x_2\in V$ and $cl(U)\cap cl(V)=\emptyset$.

(2) T_1[5] if for each $x_1, x_2\in X$ with $x_1\neq x_2$, there exist mbk-open sets U and V so that $x_1\in U$, $x_2\in V$, $x_1\notin V$, $x_2\notin U$.

(3) T_2[3] if for each $x_1, x_2\in X$ with $x_1\neq x_2$, there exist mbk-open sets U and V so that $x_1\in U$, $x_2\in V$ and $U\cap V=\emptyset$.

(4) mbk-T_2[2] if for each $x_1, x_2\in X$ with $x_1\neq x_2$, there exist mbk-open sets U and V so that $x_1\in U$, $x_2\in V$ and $U\cap V=\emptyset$.

Definition 1.2. A function $f:(X,\tau)\to(Y,\varphi)$ is called mbk-continuous[3] if $f^{-1}(V)$ is mbk-open in X for every open sets V of Y.

2. CHARACTERIZATIONS MBK-CLOSED AND CONTRA MBK-CLOSED GRAPHS

In this part, firstly we obtain some properties of mbk-closed graph functions. Then, weintroduce two classes of graphs, namely, contra mbk-closed graphs and strongly contra mbk-closed graphs and investigate various properties concerning of such these class of generalized graphs.

It is well known that the subset $\{(x,f(x))|\ x\in X\}\subseteq X\times Y$ for a mapping $f:(X,\tau)\to(Y,\varphi)$ is called the graph of f and is denoted via G_f.

Definition 2.1. The graph G_f of a mapping $f:(X,\tau)\to(Y,\varphi)$ is said to be

(1) mbk-closed[2] if for each $(x,y)\in[(X\times Y)-G_f]$, there exist mbk-open set $A\subseteq X$ and open set $B\subseteq Y$ such that $x\in A$, $y\in B$ and $(A\times B)\cap G_f=\emptyset$.

(2) contra δ-b-closed if for each $(x,y)\in[(X\times Y)-G_f]$, there exist mbk-open set $A\subseteq Y$ and closed set $B\subseteq Z$ such that $x\in A$, $y\in B$ and $(A\times B)\cap G_f=\emptyset$.

Now, we give a proof which is a characterization of mbk-closed graph functions. It is given as lemma without proof in [2].

Proposition 2.2. Let $f:(X,\tau)\to(Y,\varphi)$ be a function. Then the graph Gf of f is mbk-closed in $(X\times Y)$ iff for each $(x,y)\in[(X\times Y)-G_f]$ there exist $A\in MBKO(X,x)$ and $B\in\varphi$ $(y\in B)$ such that $f(A)\cap B=\emptyset$.

Proof. We must prove that $f(A)\cap B=\emptyset$ iff $(A\times B)\cap G_f=\emptyset$. Assume that $(A\times B)\cap G_f\neq\emptyset$. Then there exist $(x,y)\in(X\times Y)$ such that $(x,y)\in(A\times B)$, $y\neq f(x)$ and $(x,y)\in G_f$. Hence $f(x)\in f(A)$. Since $f(x)\in f(A)$ and $y\in B$, $f(A)\cap B\neq\emptyset$.

Proposition 2.3. The graph G_f of a mapping $f:(X,\tau)\to(Y,\varphi)$ is contra mbk-closed in $(X\times Y)$ iff for each $(x,y)\in[(X\times Y)-G_f]$ there exist $A\in MBKO(X,x)$ and $B\in\varphi^t(y\in B)$ such that $f(A)\cap B=\emptyset$ (ω^t denotes the family all closed sets in (Z,ω).).

Proof. This proof is similar to that of Proposition 2.2.

Theorem 2.4. If $f:(X,\tau)\to(Y,\varphi)$ is mbk-continuous and (Y,φ) is T_1-space, then G_f is contra mbk-closed in $(X\times Y)$.

Proof. Let $(x,y)\in[(X\times Y)-G_f]$. Hence $y\neq f(x)$ and since (Y,φ) is T_1-space, there exist $B\in\varphi$ such that $f(x)\in B$ and $y\notin B$. Besides, since f is mbk-continuous, of course there exist $A\in MBKO(X,x)$ such that $f(A)\subseteq B$. Therefore, we have $f(A)\cap(Z-B)=\emptyset$ and $B\in\varphi^t(y\in B)$. Finally, one obtains that G_f is contra mbk-closed in $(X\times Y)$ via Proposition 2.3.

Theorem 2.5. Let $f:(X,\tau)\to(Y,\varphi)$ is a surjective which has mbk-closed graph function. Then, (Y,φ) is T_1-space.

Proof. Assume that $y_1, y_2\in Y$ when $y_1\neq y_2$. Since f is a surjective function, there exists an $x_1\in X$ so that $f(x_1)=y_1$ and $f(x_1)\neq y_2$. Hence $(x_1,y_2)\notin G_f$ and so via Proposition 2.2, there exist $A_1\in MBKO(X,x_1)$ and $B_1\in\omega(y_2\in B_1)$ so that $f(A_1)\cap B_1=\emptyset$. Then $y_1\in f(A_1)$, but $y_1\notin B_1$. In similar way, there exists a $x_2\in X$ so that $f(x_2)=y_2$ and $f(x_2)\neq y_1$. Then, $(x_2,y_1)\notin G_f$ and using Proposition 2.2, there exist $A_2\in MBKO(X,x_2)$ and $B_2\in\omega(y_1\in B_2)$ so that $f(A_2)\cap B_2=\emptyset$. Hence $y_2\in f(A_2)$ but $y_2\notin B_2$. Therefore, $B_1\in\omega(y_2\in B_1)$ and $B_2\in\omega(y_1\in B_2)$

but $y_1 \notin B_1$ and $y_2 \notin B_2$. This shows that (Y,φ) is T_1-space.

Definition 2.6. A function $f:(X,\tau)\to(Y,\varphi)$ is called mbk-open if f (U) is mbk-open in Y for every open sets U of X.

Theorem 2.7. If $f:(X,\tau)\to(Y,\varphi)$ is mbk-open and surjective function and G_f is mbk-closed graph, then (Y,φ) is mbk-T_2-space.

Proof. Let $z_1, z_2 \in Y$ when $z_1 \neq z_2$. Since f is a surjective function, there exists an $y_1 \in Y$ so that $f(y_1)=z_1$ and $f(y_1)\neq z_2$. Hence $(y_1,z_2)\notin G_f$ and then there exist $A\in\delta BO(Y,y_1)$ and $B\in\omega(z\in B)$ so that $f(A)\cap B=\emptyset$ by utilizing Proposition 3.2. Since f is δ-b-open function, $f(A)$ is δ-b-open set containing z_1. According to Diagram, B is a δ-b-open set containing z_2. Hence, (Z,ω) is δ-b-T_2-space.

Definition 2.8. The graph G_f of a function $f:(X,\tau)\to(Y,\varphi)$ will be termed

strongly contra mbk-closed if for each $(x,y)\in[(X\times Y)-G_f]$, there exist $A\in MBKO(X,x)$ and $B\in\varphi(y\in B)$ such that $(A\times cl(B))\cap G_f=\emptyset$.

Regarding the strongly contra δ-b-closed graph, we can the following lemma.

Lemma 2.9. The graph G_f of a function $f:(X,\tau)\to(Y,\varphi)$ is strongly contra mbk-closed in $X\times Y$ if for each $(x,y)\in[(X\times Y)-G_f]$, there exist $A\in MBKO(X,x)$ and $B\subseteq Y$ is regular closed$(y\in B)$ such that $f(A)\cap B=\emptyset$.

Definition 2.10. A function $f:(X,\tau)\to(Y,\varphi)$ will be termed weakly mbk-continuous if each $x\in X$ and for each open set B of Y containing $f(X)$, there exist $A\in MBKO(X,x)$ such that $f(A)\subseteq cl(B)$.

Theorem 2.11. Let $f:(X,\tau)\to(Y,\varphi)$ is weakly mbk-continuous function and (Y,φ) is Urysohn space, then G_f is strongly contra mbk-closed.

Proof. Let $(x,y)\in[(X\times Y)-G_f]$. According to definition of G_f, $y\neq f(x)$. Since (Z,ω) is Urysohn, there exist open sets $U,V\subseteq Z$ such that $f(x)\in U$, $y\in V$ and $cl(U)\cap cl(V)=\emptyset$. Since f is weakly mbk-continuous, there exists $A\in MBKO(X,x)$ so that $f(A)\subseteq cl(U)$ and $f(A)\cap cl(V)=f(A)\cap cl(int(V))=\emptyset$ is a regular closed set in Y. Consequently, using Lemma 2.9, obtained that G_f is strongly contra mbk-closed.

Definition 2.12. A function $f:(X,\tau)\to(Y,\varphi)$ will be termed almost mbk-continuous if $f^{-1}(B)$ is mbk-open set in X for every regular open set B of Y.

Lemma 2.13. A function $f:(X,\tau)\to(Y,\varphi)$ is almost mbk-continuous iff each $x\in X$ and for each regular open set B of Y containing $f(y)$, there exist $A\in MBKO(X,x)$ such that $f(A)\subseteq B$.

Theorem 2.14. If $f:(X,\tau)\to(Y,\varphi)$ is almost mbk-continuous and (Y,φ) is T_2-space, then G_f is strongly contra mbk-closed in $(X\times Y)$.

Proof. Consider $(x,y)\in[(X\times Y)-G_f]$. Thus $y\neq f(x)$. Since (Y,φ) is T_2-space; there exist open sets $U,V\subseteq Y$ such that $f(x)\in U$, $y\in V$ and $U\cap V=\emptyset$. This is equivalent to $cl(U)\cap int(cl(V))=\emptyset$. Besides, since f is almost mbk-continuous and V is regular open, then there exists $W\in MBKO(X,x)$ so that $f(W)\subseteq V\subseteq int(cl(V))$ via Lemma 2.13 This implies that $f(W)\cap cl(U)=\emptyset$ and consequently by using Lemma 2.9, we obtain G_f is strongly contra mbk-closed in $(X\times Y)$.

To obtain next two theorems, now we give a definition which is related to MBK-closed set and characterizations of this notion.

Definition 2.15. A function $f:(X,\tau)\to(Y,\varphi)$ will be termed contra mbk-continuous if $f^{-1}(B)$ is mbk-closed set in X for every open set B of Y.

The next theorem can be obtained by using the same technique of the similar result involving MBK-continuity.

Theorem 2.16. For a function $f:(X,\tau)\to(Y,\varphi)$ the following properties are equivalent:

(1) f is contra mbk-continuous;

(2) For every closed subset B of Y, $f^{-1}(B)$ is δ-open set in X;

(3) For each $x\in X$ and each closed subset B of Y containing $f(x)$, there exists $A\in MBKO(X,x)$ such that $f(A)\subseteq B$.

Theorem 2.17. If G_f is contra mbk-continuous, then $f:(X,\tau)\to(Y,\varphi)$ is contra mbk-continuous.

Proof. Consider U is an open set of Y, then $X\times U$ is an open set of $X\times Y$. According to hypothesis G_f is contra mbk-continuous, we have $f^{-1}(U)=g^{-1}(X\times U)$ is mbk-closed in X. Therefore, f is contra mbk-continuous.

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TECHNICAL SCIENCES

GOAL-ORIENTED MOVEMENTS AT THE HUMAN BODY AND SPORT WEAPON SYSTEM

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ABSTRACT
Last decades many thousands of young people became them self as the antropotechnics systems especially with esports games. An aim of the research is to develop a model of goal-oriented movements in the human body and sport weapon system. Methods of mechanical and mathematical modeling allow for a quantitative analysis of sports activities. A mechanical and mathematical model of free oscillations of an arrow (external ballistics) was constructed, which was investigated by the Rayleigh method with successive approximation by the forms of oscillations and taking into account the conditions for the conservation of the amount of motion of a rod with inclusions free from bonds.
Keywords: Esports, weapone modeling, kinesiology, computerization, archery, antropotecnics.

Introduction

Recently, archery has become one of the most popular sports. The number of bow hunters is growing. Crossbow shooting is becoming more and more popular as a sport. In archery, the characteristic features of the shooter's sports activity attract attention. First, it is the need for the shooter to perform precise movements against the background of a significant force load in the upper limb belt. A mechanical and mathematical model of free oscillations of an arrow (external ballistics) was constructed, which was investigated by the Rayleigh method with successive approximation by the forms of oscillations and taking into account the conditions for the conservation of the amount of motion of a rod with inclusions free from bonds. The second feature is the almost instantaneous rupture of the closed kinematic chain of the upper limb belt and the change of static load to pulsed dynamic. If the aiming phase lasts several seconds, then the phase of the arrow leaving the bow is two orders of magnitude shorter (10–15 ms).

The third feature is the influence of the bow parameters on the sports result. Their contribution to shooting accuracy, with the elimination of the archer factor, which was determined using a special shooting device, is from 17 to 68%. But in order to determine the nature of the interaction between the archer and the bow, it is first necessary to develop effective methods for studying the processes occurring in the bow itself. The fourth feature is the significant influence on the dispersion of arrows of seemingly small differences in their mechanical characteristics. The shape of the arrow axis, its linear stiffness and mass, the nature of the interaction with the shelf and sidewall determine the magnitude of the longitudinal bend of the arrow shaft, and therefore the flight trajectory.

Under these circumstances, a problem arises in sports of archery, which is due to the limited capabilities of pedagogical research methods that are traditional for physical education and sports. In particular, an important way to solve such problems is the mathematization and computerization of research at the stage of describing the process of shooting from a bow, the creation of a holistic model of the "archer-bow" system. A successfully developed model, its numerical analysis method and computer implementation are effective means of scientific research in progressive areas of human activity. Next up is scientific research in sports, particular, in archery.

An aim of the research is to develop a model of goal-oriented movements in the human body and sport weapon system.

Maintaining the shooter's body balance is one of the main factors determining the sports result in archery. The shooter must maintain the balance of his body during the preparation, processing of the shot, and release. In archery, two different types of balance can be distinguished: the first – without external stimulating factors and the second in the presence of external stimulating factors. The first type of balance includes the processes preceding the release of the string. The second type includes the process of joint movement of the hand with the handle after the release of the string during its joint movement with the arrow. The second type of balance should also include the process of processing the shot during gusts of wind in open areas.

Methods of mechanical and mathematical modeling allow for a quantitative analysis of sports activities. Depending on the characteristics of motor actions and the research tasks, such models are used in different versions. A thorough analysis of the works performed in this direction was conducted by S.Yu. Alyoshinsky. He proposed a method that allows determining the controlling joint moments of human spatial movements, analyzing these movements at the kinematic, dynamic and energy levels [1].

This technique assumes that human movements are given by the coordinates of the reference points, and the force characteristics are determined as a result of solving the inverse dynamics problem. The coordinates of the reference points are recorded by the method of kinestrobe photography. The model was based on a 15-link branched kinematic chain with holonomic and scleronomic connections, which included the main segments of the human body. This model was successfully tested in studies of normal and sports walking and sprinting.

Later, B.Y. Prylutsky used an improved 16-link model with a three-element torso. The basic 17-link model of the human body (taking into account the neck as a separate link) is proposed for research into a wide range of phenomena related to human movements [2]. For research using simplified versions of models with a smaller number of degrees of freedom, the corresponding joints are subject to "freezing". However, when implemented on a computer, such changes in the model structure in specific problems do not require recompilation of the equations of motion, due to the use of a special non-classical method of solving the dynamics problem [3].

The general features of mechanical and mathematical models used for the analytical description of human movements are as follows:

- the body links are absolutely rigid;
- the links are interconnected by spherical joints;
- the centers of the joints and the center of mass of any link lie on the same straight line;
- movements are carried out using control moments acting in the joints;
- interlink forces act in the directions of lines passing through the centers of rotation of the joints;
- the ligaments are holonomic and scleronomic.

Mechanical and mathematical modeling of movements within these assumptions is not only attractive from the point of view of the possibility of obtaining quantitative parameters, but also practically real due to the emergence of reliable sources for determining the mechanical characteristics of the human body. The scientific group led by V.M. Zatsiorsky developed an acceptable method for determining the mass-inertial characteristics of body segments (foot, lower leg, thigh, hand, forearm, shoulder, head, upper, middle and lower parts of the torso) using multivariate regression equations. The equations were compiled according to the data of radioisotope analysis of adults aged 19 to 35 years, who have a level of physical development higher than average. Body length and weight were used as arguments in the regression equations [4].

On the other hand, the instrumental and software capabilities of personal computers provide practical opportunities for the implementation of these mechanical and mathematical methods.

The mechanical and mathematical model of the archer’s body should take into account the most essential features of the force load, posture and movements at different stages of the shot. It is customary to analyze the archery technique according to its following elements: the archer’s posture, which is determined by the position of the legs, body, head; the mutual position of the links of the closed kinematic chain of the upper extremities (bow - left hand - forearm - shoulder - left shoulder blade - left clavicle - sternum - right clavicle - right shoulder blade shoulder - forearm - hand - bowstring - bow); grip (way of holding the bow handle); grip (way of holding the bowstring); way of fixing under the jaw of the hand that pulls the bowstring; way of releasing the bowstring with the arrow.

Useful for determining approaches to forming a model of the shooter's body is the analysis of errors in the main elements of the technique of performing a bow shot, conducted by L.L. Desyatnikova [5]:

- unstable position of the feet relative to the shooting plane; insufficient fixation of the ankle and knee joints;
- increased mobility in the hip joints; excessive displacement of the general center of mass relative to the shooting plane; excessive twisting of the torso; deflections in the lumbar region;
- excessive tilt of the head, unstable positioning; excessive increase in pressure of the chin on the hand and on the bowstring.

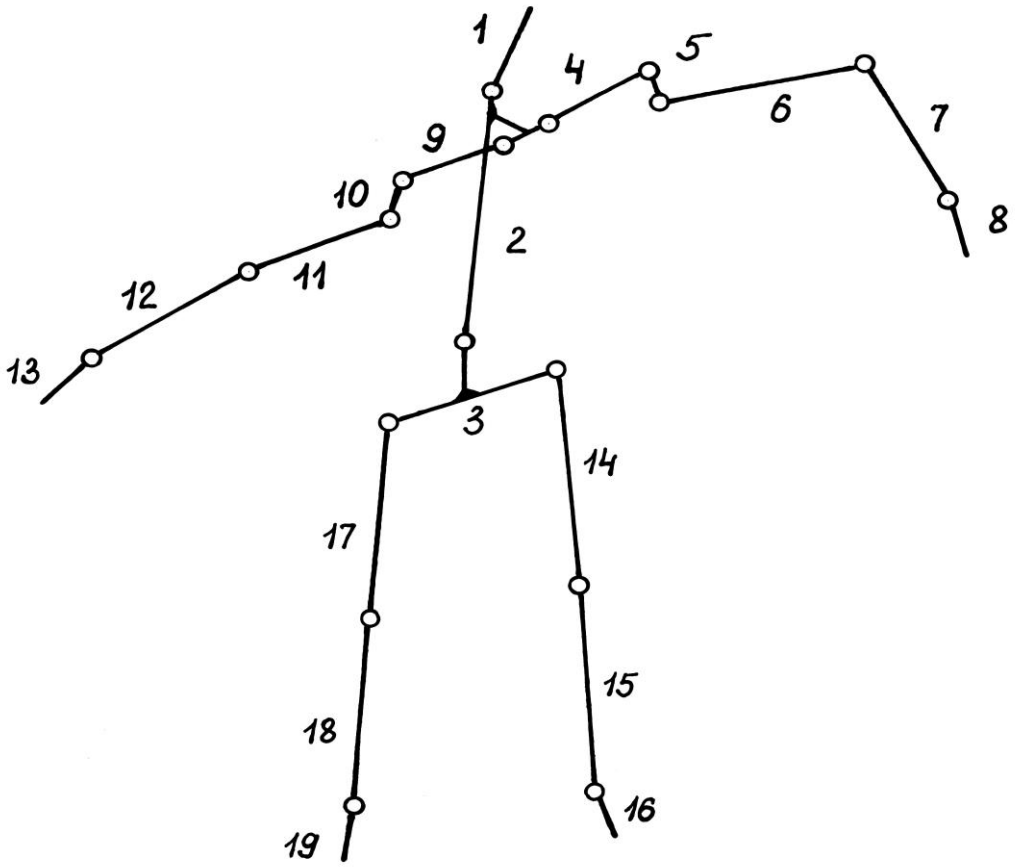

Figure 1. Schematic structure of an archery body.

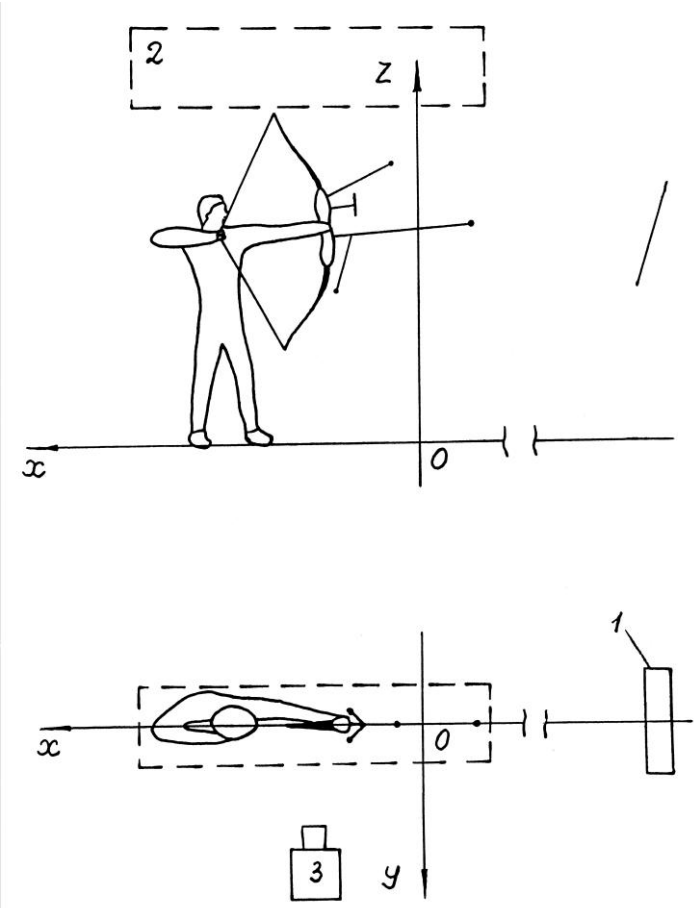

Figure 2. Schematic of a shooter's video recording: 1 - target; 2 - mirror; 3 - video camera.

One of the main errors in archery leads to loss of balance, or more precisely, to a decrease in body stability. Errors in the position of the legs are insufficient fixation of the ankle and knee joints, in the position of the torso are increased mobility in the hip joints, excessive displacement of the general center of mass relative to the plane of shooting, excessive twisting of the torso and deflections in the lumbar spine. Experimental studies by A.Ya. Korkh have proven that when the ankle joints are fixed, the body's stability increases. He also showed that the accuracy of pistol shooting increases with increasing body stability [6].

To formulate the balance task means to compose the corresponding mathematical equations describing the general conditions of balance based on the classical laws of mechanics. The mathematically expressed balance program must be consistent with the task of maintaining balance, that is, equations of the targeted distribution of support reactions must be composed.

From sports practice it is known what errors in archery are caused by non-compliance with the body balance program. Although the general balance (its task) is fulfilled, the redistribution of support reactions between the left and right legs causes deviations in the direction of arrow release. Excessive forward tilt of the torso causes instability of the shooter's position when shooting. This leads to a violation of the aiming line and the appearance of other errors: "folding", the release of the arrow with the right or lower deviation. On the contrary, the shift of the center of gravity to the heel leads to the displacement of the arrow to the left sector of the target. Shifting the center of gravity to the left leg causes head pressure on the bowstring, reduced stretch, incorrect right hand positioning, and variation in arrow release. This changes the line of sight and leads to dispersion of hits throughout the target.

Shifting the center of gravity to the right leg causes the left shoulder to be raised, additional muscle groups that hold the shoulder joint to be involved, twisting the torso, shifting the head to the side and back when pulling, and a change in the grip of the handle. As a result of the arrow's deflection on the target, dispersion occurs vertically. The total reaction of the horizontal support transmitted to the shooter's legs is a vector directed vertically upward and equal in magnitude to the weight of the shooter's body and weapon. The lines of action of these two oppositely directed vectors coincide. Separately, the reaction applied to one leg is a vector directed at an angle to the vertical (including zero). It can be considered as the sum of two components – vertical and horizontal. The vertical component is the normal reaction of the support. Together, these two components of the reactions of the two legs balance the weight of the body. The horizontal components are the friction forces of rest, which must be equal to each other, oppositely directed and have a common line of action.

In studies of the balance of the vertical posture of a person in the fields of prosthetics and orthopedicsaviation sports, attention is focused on the total vector of the reaction force, that is, on its vertical components. The horizontal components of the reactions, the sum of which in the stance on a horizontal surface is zero, remain outside the attention of researchers. The trajectories and time characteristics of horizontal movements of the general center of gravity of a person were studied using stabilography methods. The study of the equilibrium of a bowman by determining the controlling joint moments in the lower limbs, as shown above, requires taking into account the horizontal components of the reaction forces. When processing a shot, three forces act on the "bowman-archer" system, which is in equilibrium: the total weight of the archer, weapons and equipment, and the support reactions of the left and right feet (Figure 3). The vector equation of equilibrium of the system has the form: $\vec{G}_\Sigma + \vec{R}_L + \vec{R}_P = 0$.

These three vectors act at the same plane and their linear of action cross at the point *C.* Let's write down the equations of moments of these forces vs. point C_O which is a projection of the common center of gravity C_Σ of the system *XOY*:

$$R_Z^P \times Q_P C_O = R_Z^L \times Q_L C_O, \qquad (1)$$

where R_Z^P, R_Z^L are vertical components of the vectors of reaction correspondingly to the wright and left feet;

Q_P, Q_L are points of linear action of these vectors.

It is obvious, that five points C_Σ, C_O, *C*, Q_P, Q_L lie at the same vertical plane.

Projections of the forces at the vertical and horizontal axes (R_{XY}^P, R_{XY}^L) are as follows:

$$R_Z^P + R_Z^L - G_\Sigma = 0;\ R_{XY}^P - R_{XY}^L = 0. \qquad (2)$$

Taking into consideration equations (1) one can write down:

$$R_Z^P = G_\Sigma \frac{C_O Q_L}{Q_P Q_L};\ R_Z^L = G_\Sigma \frac{C_O Q_P}{Q_P Q_L};$$

$$R_{XY}^P = R_{XY}^L; \qquad (3)$$

Let's find position of the point *C* at the vertical $C_O C_\Sigma$:

$$z_C = Q_P C_O \frac{R_Z^P}{R_Z^L}. \qquad (4)$$

Coordinate z_C should not be smaller of the determine value, because determine value of the friction force ($tg\alpha = f^{-1}$):

$$z_C \geq \frac{Q_P C_O}{f}. \qquad (5)$$

Obviously, this inequality is valid for the larger of the segments $Q_R C_O$ or $Q_L C_O$. The relations (1-5) determine the task of maintaining balance. They establish dependencies between the geometric and force characteristics of the "shooter-bow" system, but do not define all of them unambiguously. Within the conditions of maintaining balance, it is possible to implement many options for balance. Outwardly, this may look like a rotation of the plane $CQ_R Q_L$ around a vertical line CC_O within the contours of contact of the feet with the support (see Fig.3). Theoretically, the points of application

of the resultant reaction forces can be located on the shaded parts of the contours of the feet.

Which of the possible options for maintaining balance the shooter's body chooses is obviously determined by the program for maintaining balance. The program depends on the goal of maintaining balance, that is, on additional conditions that do not contradict the laws of mechanics, but arise from other considerations. The shooter's goal is a sporting result, so the program should ensure that the balance is maintained in a pose that maximizes the achievement of a sporting result.

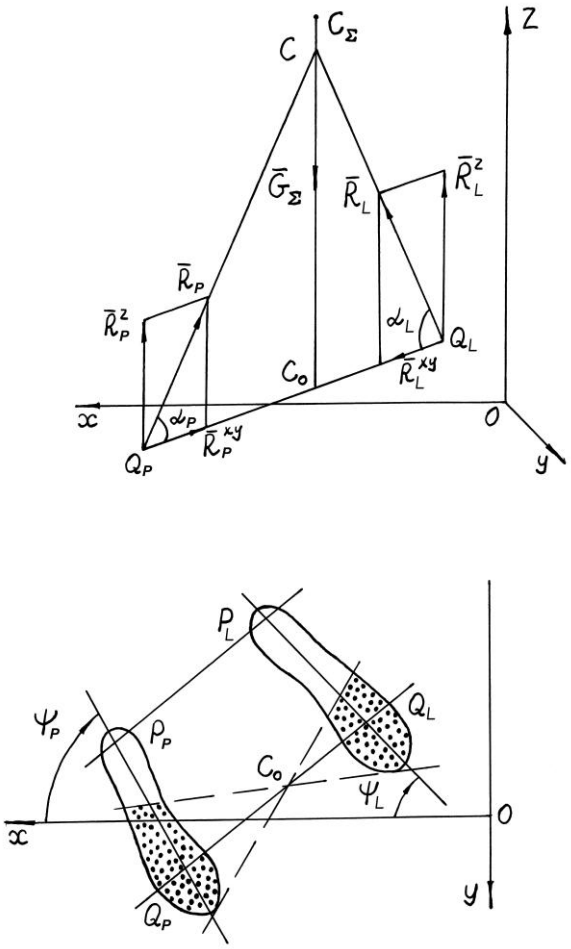

Figure 3. Scheme of the shooter's support forces.

Preparation for the shot is considered the foundation of the entire technical side of archers' sportsmanship. The more natural the pose, the more rational the movements, the longer the shooter's efficiency is maintained and the more effective his technique. Based on the fact that the shooter's pose should be as natural as possible, we can conclude that the position and support of each foot should also be as natural as possible. In particular, this means that the point of application of the reaction force should be on the midline of the foot (see Fig. 3), where *P* is the projection of the center of the ankle joint, *Q* is the point of application of the resultant reaction. Assuming this condition, we localize the positions of the resultants along two straight line segments.

The stability of the shooter's body in the sagittal plane is ensured by shifting the total center of gravity forward. In healthy people in a comfortable vertical position, the projection of the general center of gravity is at a distance of 40÷50 mm from the axis of the ankle joints. In archers in the preparation stand with a weapon, this distance reaches 100÷140 mm. The normal components of the reactions R_Z^P and R_Z^L create moments relative to the joint line $P_P P_L$. It is obvious that the distribution of these moments between the left and right feet to maintain greater stability should be proportional to the magnitude of the normal components of the reactions, i.e. the shoulders of these forces should be equal to each other. It is not difficult to deduce from the diagram (see Figure 3) that under this condition the line $Q_P Q_L$ is parallel to the line $P_P P_L$. Thus, the position of points Q_P and Q_L is determined by the intersection of the line passing through p.*C* and parallel with the lines $P_P P_L$ that are the median lines of the foot support. The problem under consideration has the form:

given – $x_{PP}, y_{PP}, x_{PL}, y_{PL}, x_C, y_C, \psi_L, \psi_P$;

determine – $x_{RP}, y_{QP}, x_{RL}, y_{RL}$.

Determination of the problem. Write down the equation of a straight line at the plane *XOY*:

$$y = a + bx .$$

Coefficients of the straight line $P_P P_L$ were determined with formulas:

$$a_P = \frac{y_{PL}x_{PP} - y_{PP}x_{PL}}{x_{PP} - x_{PL}};\ b_P = \frac{y_{PL} - y_{PL}}{x_{PP} - x_{PL}};$$

$$Q_PQ_L:\ a_R = y_C - b_Px_C;\ b_R = b_P;$$

$$P_PQ_P:\ b_P = -tg\psi_P;\ a_P = y_{PP} - b_Px_{PP};$$

$$P_LQ_L:\ b_L = -tg\psi_L;\ a_L = y_{PL} - b_Lx_{PL}.$$

Coordinates of points of forces of summer reactions R_P and R_L:

$$x_{RP} = \frac{a_P - a_R}{b_p - b_P};\quad y_{RP} = \frac{b_pa_P - a_Rb_P}{b_p - b_P};$$

$$x_{RL} = \frac{a_L - a_R}{b_p - b_P};\quad y_{RL} = \frac{b_pa_L - a_Rb_L}{b_p - b_P}. \quad (6)$$

This is how the coordinates of the application points and the vertical components of the reaction vectors are determined. The horizontal components, or lines of action of these vectors, can be specified by the vertical coordinate of point C (see Fig. 3). It is obvious that the horizontal components of the reactions are directed towards each other, since the feet are shoulder-width apart, and the shooter relies in the frontal plane on a horizontal support due to friction forces.

As already noted above, the balance maintenance program should form the most comfortable stance possible, causing the least fatigue of the shooter. From the point of view of the directions of the support reactions in the frontal plane, this would be facilitated by the minimum joint moments in the lower limbs and their girdle. And this, in turn, requires the maximum approximation of the lines of action of the support reaction forces to the centers of the joints of the corresponding limbs. Ensuring this condition is possible when placing point C in point C_Σ, that is, when directing the support reaction vectors to the center of mass of the system.

The directions and magnitudes of the support reaction vectors, taking into account the above conditions, will take the form:

$$tg\alpha_P = \frac{C_\Sigma C_O}{Q_PC_O};\ tg\alpha_P = \frac{C_\Sigma C_O}{Q_LC_O};$$

$$R_{XY} = \frac{R_Z^P}{Q_PC_O};\ R_P = \frac{R_Z^P}{sin\alpha_P};\ R_L = \frac{R_Z^L}{sin\alpha_L}. \quad (7)$$

Dependencies (6), (7) make up the program for maintaining the shooter's balance. They are compatible and related to dependencies (1- 5), which determine the equilibrium problem. These general dependencies take into account various features of the shooter's individual technique, type of stance, weapon, etc. Dependencies (6), (7) reveal the general static uncertainty of the problem of the shooter's two-support stance.

Now let's perform a force analysis of the remaining links of the shooter's body. The calculation scheme of a conditionally separated link of the body takes into account the force of its weight G_i, joint forces F_{ij}, F_{ik} and joint moments M_{ij}, M_{ik} from neighboring links $j = i - 1$; $k = i + 1$ (Figure 4). This scheme can be considered in a simplified version (head 1, hands 8, 13 have one joint each) or in a complicated version (upper body 2 has four joints, and lower body – three).

Using the Poinsettia method, we reduce the spatial system of forces and moments applied to the link as a rigid body to statically equivalent to one force – the main vector applied to the center of mass of the link, and one pair of forces with a moment equal to the main moment of the system of forces relative to the center of mass. Then the sufficient and necessary conditions for the equilibrium of the body link will be the conditions of equality of the main vector and the main moment to zero.

The equilibrium equations of the body link in vector form have the form:

$$\vec{F}_{ij} + \vec{F}_{ik} + \vec{G}_i = 0;$$

$$\vec{M}_{ij} + \vec{M}_{ik} + \vec{G}_i \times \left(\vec{r}_i - \vec{r}_{ij}\right) + \vec{F}_{ik} \times \left(\vec{r}_{ik} - \vec{r}_{ij}\right) = 0, \quad (8)$$

where $\vec{r}$ is radius vectors of characteristic points of the link: joints and center of mass.

In projections on the axis of the fixed coordinate system *OXYZ* from (8) we obtained equations:

$$F_{ij}^x = -F_{ik}^x;\qquad F_{ij}^y = -F_{ik}^y;$$

$$F_{ij}^z = G_i - F_{ik}^z;$$

$$M_{ij}^x = G_i\left(y_{Ci} - y_{Pij}\right) - F_{ik}^z\Delta y_i + F_{ik}^y\Delta z_i - M_{ik}^x;$$

$$M_{ij}^y = G_i\left(x_{Ci} - x_{Pij}\right) - F_{ik}^x\Delta z_i + F_{ik}^z\Delta x_i - M_{ik}^y;$$

$$M_{ij}^z = F_{ik}^x\Delta y_i - F_{ik}^y\Delta x_i - M_{ik}^z; \quad (9)$$

where $\Delta x_i = x_{Pik} - x_{Pij}$; $\Delta y_i = y_{Pik} - y_{Pij}$; $\Delta z_i = z_{Pik} - z_{Pij}$.

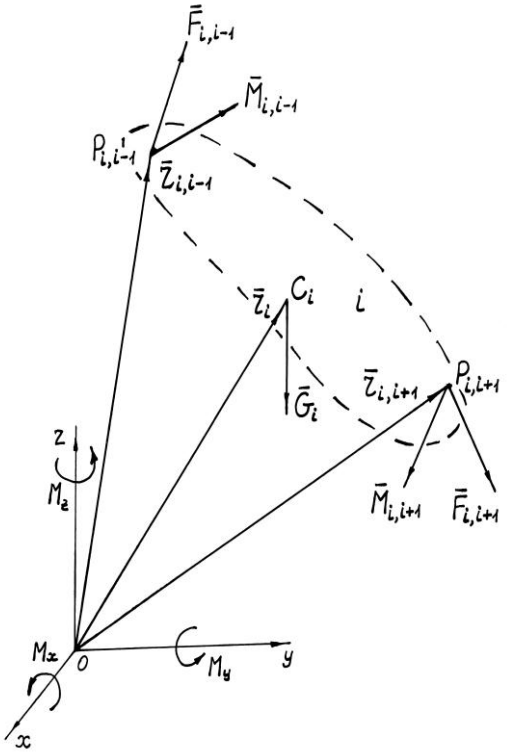

Figure 4. Calculation scheme of the archer's body link.

The forces of interaction between the archer and the bow, acting in the vertical plane, are determined from the obvious relationships (Figure 5):

$$G_B = G_A + G_H; \quad \frac{G_H}{G_A} = \frac{x_A - x_C}{x_C - x_H}, \quad (10)$$

G_B – bow weight; G_A, G_H – components of the bow weight correspondingly to the string and the handle.

Then from (10) one can determine:

$$G_A = G_B \frac{x_C - x_H}{x_A - x_H}; \qquad G_H = G_B - G_A. \quad (11)$$

$$F_H = \sqrt{(F_B cos\alpha_B)^2 + (F_B sin\alpha_B + G_H)^2};$$

$$cos\alpha_H = \frac{F_B cos\alpha_B}{F_H};$$

$$cos\alpha_A = \frac{F_B cos\alpha_B}{F_A};$$

$$tg\alpha_B = \frac{z_A - z_H}{x_A - x_H};$$

$$F_A = \sqrt{(F_B cos\alpha_B)^2 + (F_B sin\alpha_B + G_A)^2}. \quad (12)$$

Bow forces acting at the horizontal plane determine outing of the line *AH* off the vertical plane on the angle β <<1. Therefore, one can wright down:

$$F^x_{8H} = F_H cos\alpha_H;$$

$$F^x_{13A} = -F_A cos\alpha_A;$$

$$F^y_{8H} = -F^y_{13H} = F^x_{8H}\beta, \quad (13)$$

where $\beta = \frac{y_A - y_H}{AH}$ <<1 (see Figure 5) (14)

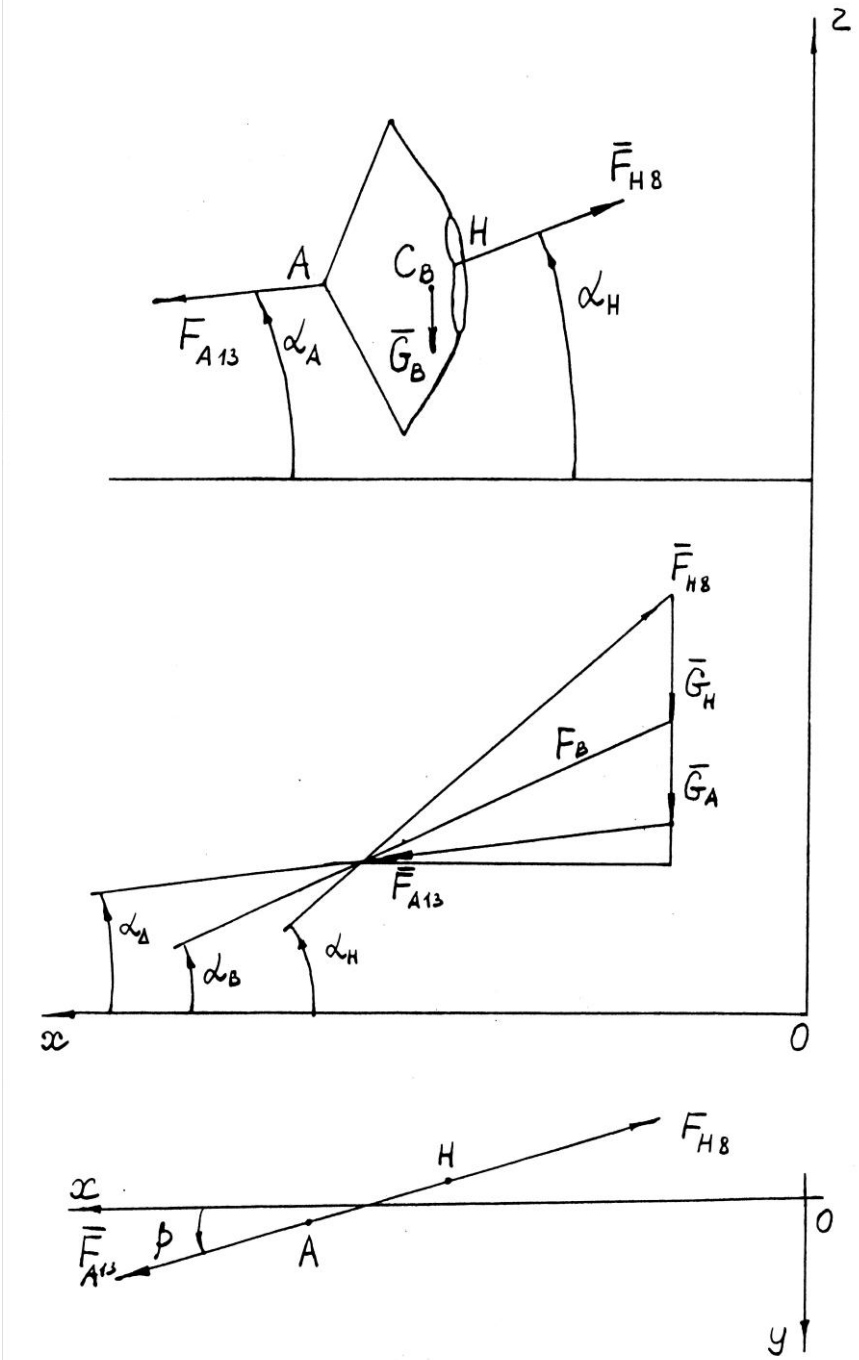

Figure 5. Scheme model of the bow and bow interaction.

One can check results of the problem using equations as follow:

$$F_{8H}^{x} = -F_{13H}^{x} = F_H \cos\alpha_H = F_A \cos\alpha_A = F_B \cos\alpha_B$$

$$F_{8H}^{x} = -F_H \sin\alpha_H ;$$

$$F_{13H}^{z} = F_A \sin\alpha_A ;$$

$$F_{8H}^{z} + F_{13A}^{z} = -G_B .$$

Algorithm of the forces analysis of the upper part of body has been presented in Table 1.

Table 1.

Algorithm of the forces analysis of the upper part of body

Step	Archer's body and bow parts (see Figure 1)		
	i	*j*	*k*
1	7	8	H
2	6	7	8
3	5	6	7
4	4	5	6
5	2	4	5
6	12	13	A
7	11	12	13
8	10	11	12
9	9	10	11
10	2	9	10
11	2	1	-
12	3	2	1, 4, 9

Conclusions

Based on the analysis of the movement actions of an archer, a 19-link branched spatial kinetic chain was adopted as the model of his body, consisting of absolutely rigid elements (body links) connected by spherical holonomic, scleronomic hinges. A model of maintaining the balance of the archer with a bow was developed, and the problem of force analysis of the archer's body was posed and solved. Within the framework of a quasi-statistical approach, the acceleration field of the archer's body links at the moment of breaking the closed kinematic chain of the upper belt and limbs at the moment of releasing the bowstring was modeled. As a result of comparing the patterns of human muscle activity with the time characteristics of a bow shot, the assumption of the invariance of the values of joint moments in the archer's body over the time segment of the joint movement of the arrow with the bowstring was substantiated. Dependencies for the accelerations of the links, joint forces, and support reactions were obtained.

A mechanical and mathematical model of a sports bow with lumped and distributed parameters has been developed: the handle is modeled by an absolutely rigid body, the arms by geometrically nonlinear flexible rods within the framework of the Bernulli and Saint-Venant hypotheses, the bowstring by an elastic thread, the arrow and stabilizers by rods within the framework of the technical theory of bending. Differential equations, boundary and initial conditions for the problems of statistics (aiming) and dynamics (string release) have been written. The analysis of the bow arm bending model has been carried out using the approximate energy method, which allowed obtaining a solution to the problem in a closed analytical form. It is shown that the adopted hypothetical forms of changing the angle of rotation of the shoulder cross-section lead to errors in displacements and forces within one percent. An algorithm has been developed and recurrent dependencies have been constructed, which make it possible to obtain characteristics of the stressed-deformed shoulder that are satisfactory in accuracy for engineering calculations.

A mechanical and mathematical model of the archer's paradox is proposed, which describes the experimentally recorded phenomenon of the arrow bending around the bow handle after the archer releases the string. As a result of solving the Cauchy problem describing the motion of the "athlete-bow-arrow" system, it was established that the transverse movements of the arrow, in addition to the known bending deformations, also include its movement as a rigid body together with the string seat and plunger. A mechanical and mathematical model of the mechanical longitudinal bending of an arrow (internal ballistics) has been developed. The model has been investigated by the method of expanding solutions into a power series. Analysis of the results allows us to state that, other things being equal, the stiffness of the bowstring affects the frequencies of bending vibrations of the arrow much more than the mass of the bow. With an increase in the force of the bow, the frequencies decrease, and at a critical value, a dynamic loss of stability of the arrow occurs, and periodic oscillations turn into a monotonic increase in the bending of the arrow, which deviates from the given direction.

A mechanical and mathematical model of free oscillations of an arrow (external ballistics) was constructed, which was investigated by the Rayleigh method with successive approximation by the forms of oscillations and taking into account the conditions for the conservation of the amount of motion of a rod with inclusions free from bonds. As a result of a computational experiment using a specially developed algorithm, dependences for the frequency of the fundamental tone of bending oscillations of an arrow were obtained, which are described by a generalized design scheme typical of modern sports arrows. An engineering methodology has been created for analyzing the efficiency of a sports bow, i.e., assessing the share of potential energy of the shoulders and bowstring that is converted into the kinetic energy of the arrow. It has been established that a significant factor affecting the efficiency of a bow is the stiffness of the bowstring. Increasing the stiffness and reducing the mass of the bowstring, other things being equal, leads to an increase in the efficiency of the bow and a decrease in dynamic loads on the bow. Based on this, it can be recommended to use materials for bowstrings in the following sequence, with the preference for Kevlar, Dacron, and Lavsan. It seems promising to use high-modulus carbon fibers for the manufacture of bowstrings. It is shown that when calculating the parameters of a sports bow, it is mandatory to take into account the displacements

caused by the tension of the bowstring. At the moment of arrow separation, the mass of the bowstring brought to the socket can be taken equal to one third of its total mass. At the moment of arrow separation, the mass of the bowstring brought to the socket can be taken equal to one third of its total mass. The arrow separation occurs somewhat deeper than the position of the bowstring attachment, which is caused by the flexibility of the bowstring, dynamic forces of the shoulder and the pinching of the bowstring by the arrow shank. This leads to a decrease in the efficiency of the bow, rather than an increase, as previously thought. The results obtained are in good agreement with experimental data on the efficiency of the bow.

A comprehensive instrumental and software methodology has been developed for measuring the characteristics of an archer's movements during execution and preparation for a shot with the presentation of results in a convenient, understandable form for the athlete and coach. The instrumental part of the methodology includes modern equipment for accelerometry, tensometry, geniometry, stabilography, and video analysis of images. Registration and processing of measurement results is carried out on a personal computer using interfaces for analog-to-digital conversion and input of signals from information sensors and video images into the computer. A comprehensive instrumental and software methodology has been developed for measuring the characteristics of archer movements when performing and preparing for a shot with the presentation of results in a convenient, understandable form for the athlete and trainer. The instrumental part of the technique includes modern equipment for accelerometry, tensometry, geniometry, stabilography, video analysis of images. Registration and processing of measurement results is carried out on a personal computer using interfaces for analog-to-digital conversion and input into the computer of signals from information and video image sensors.

Engineering recommendations

Based on the results of modeling and methods of analyzing the characteristics of a shot from a sports bow, it can be considered appropriate to conduct further research in the following directions:

• In the direction of improving the method of modeling the movements of the shooter's body –, this is an in-depth anatomical and biological analysis of muscle activity; measurement of mass inertial characteristics of body links of archers; study of the nature of the interaction between individual muscles, which is essential from the point of view of the density of their styling; clarification of the mutual positions of the axes of the hinges modeling the joints of the surface of the bones.

• In the direction of clarifying the calculation model of the sports bow –, this is taking into account the flexibility of the bow handle, which becomes relevant with the existing tendency to lighten the handles and using plastic masses for their manufacture; modeling the layering of the bow shoulder and the shape of the rounding of its end; development of a model of the bow string as a multi-stranded twisted thread; study of the archer's paradox on the nature of pinching the string with an arrow shank.

• In the direction of the implementation of the method of modeling and analysis of shot characteristics in sports practice –, this is a study of the force of interaction of the shooter's hand with the bow handle; study of the influence of the design, mass, stiffness and position of stabilizers on the characteristics of the internal and external ballistics of the arrow; analysis of the influence of the geometric dimensions of the arrow on its stiffness, stability and natural frequencies of oscillations; combination of the results of axclerometric, tensometric and video graphic studies with pedagogical evaluations of the shooting technique.

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